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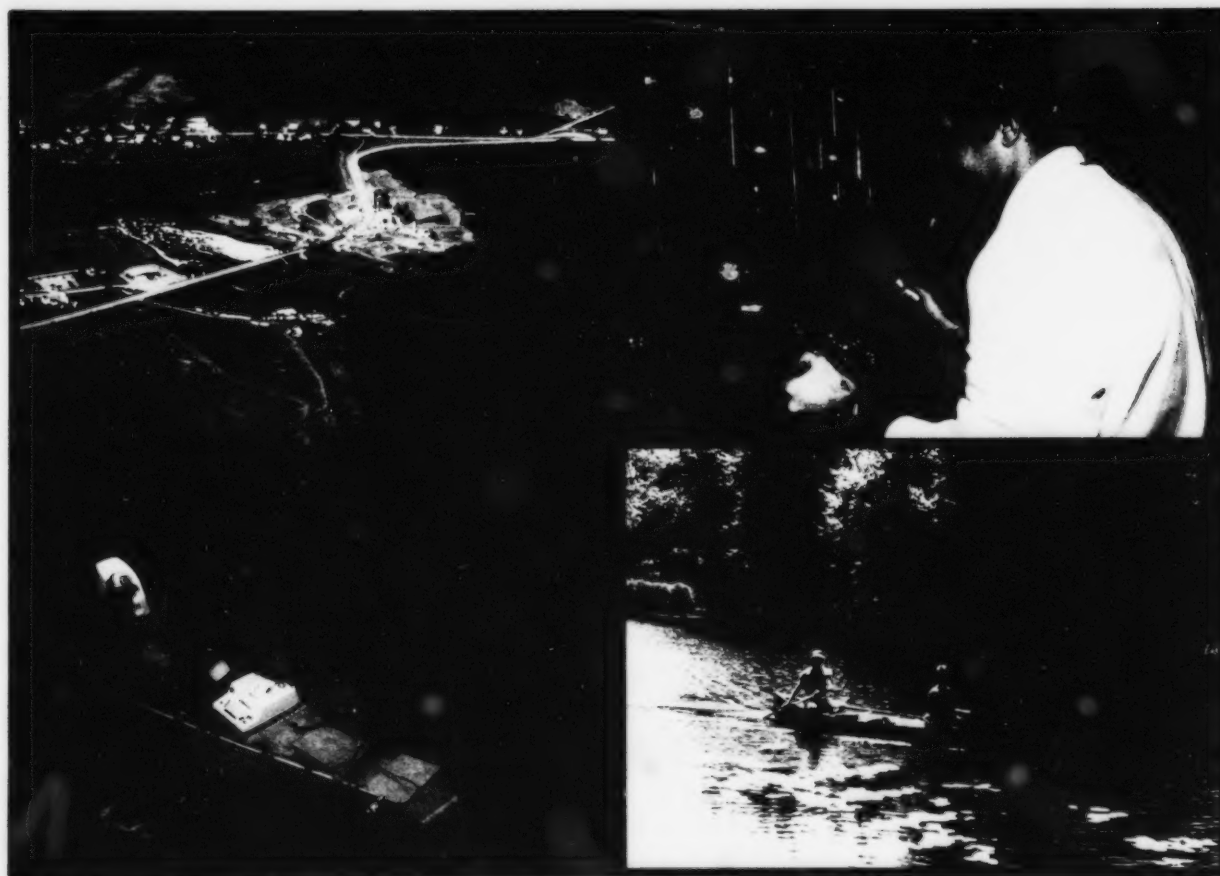
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HISTORICAL OVERVIEW OF WATER QUALITY IN NEW BRUNSWICK 1961-1979

IWD-AR-WQB-89-147



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**Inland Waters Directorate
Atlantic Region
Water Quality Branch and
Water Planning and Management
Moncton, N.B./Dartmouth, N.S., 1989**

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INLAND WATERS DIRECTORATE
ENVIRONMENT CANADA

Edited by
P.E. Belliveau

Inland Waters Directorate
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ABSTRACT

The surface- and ground-water quality data collected by the federal and provincial agencies in New Brunswick during the period from 1961 to 1979 have been assembled, screened, analyzed, and then interpreted in conjunction with available socioeconomic and physiographic information.

For the purpose of data analysis, interpretation, and discussion, the province of New Brunswick has been divided into seven basins: the Miramichi; the Restigouche; the upper, middle, and lower Saint John; and the western and eastern coastal. The water chemistry in these basins is discussed in relation to industrial, agricultural, forestry, and municipal activities, land use, geology, and the physiography of the respective region. Also, water quality is compared with water quality criteria or guidelines to assess the suitability of surface and ground water for use as drinking water sources and the protection of freshwater aquatic life.

RESUME

Les données sur la qualité des eaux de surface et souterraines recueillies par les organismes fédéral et provincial au Nouveau-Brunswick de 1961 à 1979 ont été rassemblées, triées, analysées et interprétées conjointement avec l'information socio-économique et physiographique disponible.

Aux fins de l'analyse et de l'interprétation des données, la province du Nouveau-Brunswick a été divisée en sept bassins : ceux de la Miramichi, de la Restigouche, du bas, moyen et haut St-Jean et les bassins côtiers occidental et oriental. La chimie des eaux de ces bassins est examinée en fonction des activités industrielles, agricoles, forestières et municipales, de l'utilisation des terres, de la géologie, et de la physiographie des régions respectives. En outre, la qualité des eaux est comparée aux critères ou directives en matière de qualité de l'eau de façon à évaluer si les eaux de surface et souterraines peuvent être rendues potables et si la vie aquatique dans les eaux douces est protégée.

FOREWORD

Canada is a land endowed with an abundance of fresh water contained in a myriad of sparkling streams and lakes as well as large navigable rivers. Along with a growing awareness that our water resources are limited in certain areas of Canada, concerns for the quality of the water throughout Canada are rapidly developing.

Most water uses, be they recreational, agricultural, industrial, or domestic, have specific requirements for the quality of the water resource. Therefore, water quality has a profound effect on the social and economic development of an area.

Environment Canada has monitored the quality of Canada's major surface waters for many years. The National Monitoring Program carried on by the Water Quality Branch has gradually expanded to include approximately one thousand sampling sites, which reflect national, regional, and local water quality concerns. The data collected are stored in NAQUADAT, a computerized data management system, and are periodically published in summary and detail in the Water Quality Branch Data Report Series. Although these reports have proven valuable as reference data sources, it has been realized that the reports can only be fully utilized by persons familiar with the interpretation of water quality data. In order to involve a wider audience in the appreciation of water quality, Water Quality Interpretive Reports are published. By utilizing the current and historical water quality data collected by both federal and provincial agencies, this type of report provides new insight into the water quality. These reports emphasize pertinent water quality information through the use of graphical, tabular, and concise textual presentations.

Individual reports aim at interpreting regional water quality data for a broad spectrum of uses, and it is hoped that they are informative and useful to the public and to resource planners.

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SUMMARY

This report documents the impact of both natural and anthropogenic influences on water quality in the various watersheds of New Brunswick. The objectives established for this report were to characterize the water quality conditions on a macro scale in the province during the period from 1961 to 1979, and to interpret some of the water quality spatial variations found in the province.

All available federal and provincial water quality data for the period from 1961 to 1979 were gathered, collated, and screened, and a working data base was created, ultimately comprising 375 surface-water and 150 ground-water sites.

For the purpose of this report, the province was divided into seven basins or watersheds: the Miramichi, Restigouche, upper Saint John, middle Saint John, lower Saint John, western coastal, and eastern coastal river basins.

The land use and physical resources information used in this report was collected and mapped at a scale of 1:500 000 and then interpreted at the third-order watershed level. These illustrative maps were interpreted as general influences of land uses on water quality.

The 1981 estimated New Brunswick population was 709 100, with approximately 60% of the inhabitants living in urban centres. The population has concentrated along the many rivers. Municipal and central sewage treatment systems are provided to various communities and urban centres. Other municipalities utilize tidal flow to eliminate domestic sewage accumulation.

The largest industries are those manufacturing industries based on forest resources, followed by agriculture, fisheries, and beverage manufacturing. Raw materials produced in the province include base metals, peat moss, and coal.

The predominant land use in New Brunswick is productive woodland. Plantations and artificially reforested areas constitute 76% of land use by area in the province. In general, productive woodland is more prevalent in the northern and inland basins. Seven forest ecoregions have been described in the province. These ecoregions contain 92% of the forested area, of which 55% is privately owned. The harvesting of the forests centres on the softwood species. In cutover areas, the net budgetary losses for calcium, magnesium, sodium, potassium, and nitrate were 9, 8, 3, 20, and 100 times greater, respectively, than those in comparable undisturbed watersheds during the same period. Loss of soil cover resulted in increased stream discharges and sediment loads, as well as in increases in some major ions and nutrients in the Nashwaak watershed. Burn activity increased alkalinity levels in the recharge water.

Other land uses include improved pasture and forage, nonproductive woodland, and rough grazing and rangeland, together constituting approximately 1% of land use by area. Mines, quarries, and pits, plus outdoor recreation and built-up areas, form approximately 6.5% of provincial land use. Swamps, marshes, bogs, and croplands constitute the remaining 2.5% of the provincial area, notably the "potato belt" area located in the upper and middle Saint John River basins.

The physiography of the province varies from the Miramichi Highlands to the lowland areas along the Gulf of St. Lawrence Plain. About 60% of the province's 72 520 km² is forested highlands. Lakes and estuaries make up 1607 km² of New Brunswick's total surface area. The principal physiographic divisions in the province are the Notre Dame Mountains, the Chaleur Uplands, the New Brunswick Highlands, and the Gulf of St. Lawrence

Plain. The undulating to gently rolling topography of New Brunswick's lowland plain has developed poor surface drainage; therefore, numerous creeks, brooks, swamps, and bogs occupy the area.

The bedrock in the province is composed of various igneous, metamorphic, and sedimentary groups. The chemical quality of surface waters passing through and over these geologic influences is generally excellent. Calcium bicarbonate-type waters predominate, although mixed chemical influences have been observed at several locations.

The highlands of New Brunswick include local flow systems that contribute only small amounts of total dissolved solids to the streams. Total dissolved solids were consistently higher in streams affected by dissolved calcium originating from the metamorphosed uplands.

Calcium, turbidity, sulphate, and chloride concentrations measured in New Brunswick streams showed general increases from highland areas to lowland areas. The upland terrain surface water reflected the lowest mean sodium concentration (2.0 mg/L), and the lowland sedimentary basins had the highest (5.0 mg/L). Magnesium values were lower than sodium concentrations in the streams of igneous, sedimentary, and mixed influences. Calcium concentrations remained consistently higher than sodium concentrations in streams from all sub-basins.

Most of the New Brunswick surface waters have limited buffering capacity and are sensitive to increased acidic inputs, either natural or anthropogenic. Alkalinity and pH values were low in all terrain types. The metamorphosed upland surface water alkalinity and pH were the highest values recorded in New Brunswick, averaging 55 mg/L and 7.6, respectively.

The hydrological regime is a major factor in the quality of surface waters. Alkalinity, hardness, and minerals generally decreased in New Brunswick streams when streamflows increased and vice versa. In the north temperate areas that receive acid precipitation, the pH in streams often reaches a minimum during early snowmelt. This pH "shock" is commonly followed by peak flow and marked dilution of major ions. The pH values of rainfall in the Atlantic region are generally below 5.0. The most sensitive part of New Brunswick is the southwest, where a formation of Devonian granite is found. The Lepreau River watershed occupies much of this granite area and has the lowest pH values in the province.

Ground-water quality is determined in part by the geochemical makeup of the bedrock. Low mineral concentrations reported in this study can be attributed to the relatively insoluble nature of crystalline rocks through which the ground water passed. Pre-Carboniferous aquifers usually have short flow paths, and this tends to reduce the potential for dissolution of minerals from the host rock.

Ground waters of the Pennsylvanian group were found to be of variable quality. The majority were of the bicarbonate type, approximately equally divided between calcium and sodium cation predominant. Some chloride, a few sulphate predominant and some waters not clearly defined make up the rest.

In New Brunswick, seawater intrusion into Carboniferous bedrock has been observed along the Chaleur Bay and the Gulf of St. Lawrence coasts. The Chatham area, Kouchibouguac National Park, and the Moncton area have also been observed to contain sites of intrusion.

Highly saline ground waters, which cannot be attributed to seawater intrusion, have been reported in several of the Carboniferous areas in New Brunswick. In many cases, these mineralized ground waters are directly attributable to evaporites such as gypsum or anhydrite. However, saline ground waters occur in areas of no known evaporite deposits. Areas affected are Irishtown, Salina, Plaster Rock, Fredericton, Tracy, Oromocto, and Chipman.

The climate in New Brunswick is a modified continental type. The climate is cold in the winter and warm in the summer, with occasional influxes of Atlantic air creating some mild spells in winter and cool spells in summer. The accumulation of snow during the winter and its subsequent runoff play a significant part in the hydrology of the province. Snowfall constitutes about 20% to 25% of the total annual precipitation in coastal areas of New Brunswick and up to 35% to 40% in highland areas.

A trend for surface and ground waters with a higher proportion of chloride, derived from sea spray, is found in the eastern and western Fundy watersheds and in part of the lower Saint John watershed. The phenomenon is also apparent in the southern half of the eastern coastal watershed.

There are a number of water quality impacts associated with agricultural activities. The application of fertilizers and pesticides to agricultural land in New Brunswick has enriched receiving waters and created a potential negative impact on downstream water resources for recreation, water supply, and fisheries.

Soil erosion and sedimentation in streams resulting from agricultural practices have a greater potential for aquatic environmental damage than from forestry operations. In New Brunswick, however, the actual extent of damage from farmland erosion is substantially reduced by the relatively low proportion of land used for agricultural purposes. It has been calculated that 37-74 t/ha of topsoil are eroded from farm fields each year.

Pasturelands are scattered throughout the southeastern portions of the province. The heaviest concentrations are in King's and Westmorland counties with lesser amounts in Kent County. The animal husbandry activities in these areas have contributed to the organic content of the Kennebecasis River and its tributaries, the Studholm and South Branch rivers, the Petitcodiac and North rivers, the Memramcook River basin, the headwaters of the Buctouche and Richibucto rivers, and the upper Saint John River from Connors to Edmundston.

Industrial activities vary from basin to basin. In both the Miramichi and Restigouche river basins, base metal mining is an important activity in addition to the extensive utilization of the forest resource bases. Recreation and tourism based on Atlantic salmon fishing is also significant. Other industries include chemical products, pulp and paper, thermal generating stations, and industrial parks.

Industrial point sources contributing pollution loads to the aquatic environment in New Brunswick consist of the food processing and the pulp and paper industries. Food processing industries are major sources of water pollutants. An example is the McCain food-processing operation. It affected TOC levels in the Saint John River, especially between Edmundston and Saint Leonard, and also at Florenceville.

Meat products and processing industries contributed to the water quality degradation of receiving waters in New Brunswick. Nadeau Poultry Farms Ltd. has influenced the organic content of the Saint John River. Piers Piggery also contributed to high TOC concentrations in the river.

Large amounts of solids were found in the wastewaters of fruit- and vegetable-processing plants. Potato starch wastes from one New Brunswick plant operating at full capacity typically had an average polluting effect equivalent to 20 000-36 000 people.

The brewing industry's process water usually had high BOD (between 120 and 1200 mg/L), suspended solids of 200-500 mg/L, and pH values of 5.5-7.4. Softdrink wastewaters are generally alkaline and moderately high in both suspended solids and BOD. Industry surveys suggest that about 80% of wastewaters from Maritime plants were discharged into municipal sewer systems during the review period. Since these were not treated, they resulted in high BODs.

Base metal mining operations in New Brunswick are located in the highlands, and thus in headwater areas. For the most part, ores are metallic sulphides, including copper, lead, zinc, antimony, and bismuth sulphides. Acid mine drainage was the dominant impact. Up to the mid-1970s, the untreated acid mine drainages contributed high sulphate, high heavy metals (copper, zinc, and iron), and low pH values. Since the mid-1970s, treated effluents resulted in high sulphate values, a median pH value of 7.0, and calcium values as high as 1400 mg/L, with a median of 154 mg/L. Heavy metal levels downstream from the tailings pond outfall were low.

Coal mining in New Brunswick is prominent in the Minto-Chipman area. Clear cutting, erosion and siltation, and acid mine drainage are the significant water quality impacts. The only observed problem with discharge from the Chipman operation, however, was high turbidity. Heavy metal concentrations, except for lead, were low, and pH ranged from 7.6 to 8.0, indicating no acid production. In Iron Bound Cove, however, acid mine drainage was evident from coal mining drainage.

Average pulp mill production from New Brunswick mills is 506 t/d per mill, with outputs ranging from a high of 873 t/d to a low of 49 t/d. By 1979, however, pulp and paper waste toxicity to aquatic life in receiving waters was being addressed by the responsible agencies.

Basin water types in New Brunswick ranged from basically calcium bicarbonate with varying amounts of sulphate to varying amounts of sodium chloride. Surface-water quality of the Miramichi, Restigouche, and upper and middle Saint John river basins generally reflected the calcium bicarbonate waters, with varying proportions of sodium sulphate present. The water types of the remaining basins were influenced in part by saltwater intrusion and sea spray. The majority of the areas sampled were mixed calcium bicarbonate/sodium chloride-sulphate types.

In the Miramichi River basin, most of the surface- and ground-water sites sampled were found suitable for use as drinking water sources. The biggest problem in ground water appeared to be manganese, and some of the ground-water wells were probably contaminated by saltwater intrusion. There were also a few examples of saltwater intrusion into aquifers in the Nigadoo area. Many of the surface waters in the Restigouche River basin were found unsuitable for use as drinking water supplies. Frequent noncompliance of metals and sulphates occurred in the mining and smelting areas.

In the upper Saint John River basin, many of the surface waters were found unsuitable for use as raw drinking water supplies. The most troublesome parameters in the basin were colour, iron, manganese, and turbidity.

In the middle Saint John River basin, 85% of the ground waters sampled were predominantly bicarbonate type. Elevated magnesium and sodium chloride levels were recorded in the remaining samples. The majority of the surface waters contained calcium bicarbonate with

variable levels of sulphate. The more frequent noncompliant parameters for the protection of aquatic life were alkalinity, copper, dissolved oxygen, pH, phosphate, and zinc.

The surface-water types in the lower Saint John River basin were dominated by calcium bicarbonate. Other surface-water sites on the Canaan, Otnabog, Oromocto, and Upper Salmon rivers exhibited mixed water types, composed of calcium carbonate with varying levels of sodium, chloride, and sulphate. A strong marine influence was evident in Spruce Lake, located near the Fundy coast. The coal mining area, around Minto and the Little, Newcastle, Salmon, and Jemseg rivers exhibited elevated sulphate levels typical of coal mine drainage.

The ground waters in this basin were variable in water type. Extreme proportions of sulphate were recorded in the coal mining areas. Excessive chloride concentrations were also reported in the Hampton area. The major cation was calcium rather than sodium. In general, the ground-water quality of the Saint John River basin is very good and quite suitable for use as drinking water supplies. Iron and manganese are the biggest problem in drinking water supplies.

Alkalinity, copper, and phosphate were in noncompliance for the protection of freshwater aquatic life in the various Saint John River basins. Other noncompliant parameters exceeding the guidelines for the protection of freshwater aquatic life occurred in one or more of the Saint John River basins. They were cadmium, iron, pH, zinc, nickel, and dissolved oxygen. The high metal concentrations can be associated with the geology, and the phosphate can be associated with the agricultural land use in the above basins. Phosphate noncompliances were reduced as distance increased from the agricultural belt along the Saint John River.

The western and eastern coastal basins exhibited water types influenced by the marine environment. The majority of the sites sampled were mixed calcium bicarbonate/sodium chloride-sulphate types.

The ground-water quality in the coastal basins reflected some seawater intrusion and evaporitic and dolomite deposit influences. The majority of the samples, however, were calcium carbonate. Several sites had typical calcium-magnesium bicarbonate water. This was probably a result of the dolomite bedrock. Another site exhibited a calcium and magnesium sulphate composition, and was related to the gypsum deposits found in the basin.

In the western coastal basin, the only severe problems for raw drinking water supplies were low alkalinity, high colour, and both high and low pH's, all of which are mainly natural in origin. For the protection of freshwater aquatic life, alkalinity, aluminum, and copper were in noncompliance. The low dissolved oxygen is directly related to anthropogenic activities, especially the pulp and paper industry.

In the eastern coastal basin, the problem parameters for raw drinking water supplies were alkalinity, colour, pH, and turbidity. These noncompliance parameters were a result of natural geological and peat bog influences. The ground-water problem parameters were colour, iron, manganese, TDS, and turbidity. For the protection of freshwater life the parameters of major concern were found to be alkalinity, copper, and zinc.



CHAPTER ONE

INTRODUCTION

The objectives of this report are to characterize water quality conditions in the province of New Brunswick, to interpret the water quality spatial variation in the province, to identify the influences of certain variables on water quality characteristics of identified river basins, and thus to offer the reader a clear notion of the existing water quality in New Brunswick. These variables encompass the geology, physiography, hydrological regime, land use activity, and economic scheme of the province of New Brunswick. Seven river basins were selected for inclusion in this report. All available federal and provincial water quality and quantity data for the province of New Brunswick for the period from 1961 to 1979 were evaluated and interpreted.

1.1 Conceptual Framework for the Interpretation

The Water Quality Branch (WQB), Environment Canada, has previously prepared water quality interpretive reports for Prince Edward Island and Ontario. These were used as prototypes for this report, although certain improvements in the interpretation and presentation of data were introduced in this report. These changes encompassed two broad categories:

- (a) The creation of a comprehensive data base containing both existing federal data stored on NAQUADAT and solicited provincial data. This data base included ground- and surface-water quality information.
- (b) An emphasis on the influences of both economic and physical variables on water quality conditions throughout the province of New Brunswick. These aspects were not considered in the previous reports.

1.2 Selected Water Resources Programs in New Brunswick

Various water resource programs had been initiated up to the period of this study. These programs included the monitoring and surveying of most of the basins in the province, and had a variety of objectives reflecting the complexity of the problems studied.

1.2.1 Federal Water Quality Programs

The Water Quality Branch (WQB) of Environment Canada has undertaken numerous water quality studies in New Brunswick since 1965 (Belliveau and Lockerbie, 1981). The International Hydrological Decade (IHD) National Water Quality Monitoring Program was the first major monitoring effort; it consisted of 68 locations sampled monthly from August 1966 to April 1974. The water samples were analyzed for major ions, nutrients, and metals.

In June 1971, the Water Quality Branch initiated the Saint John River Basin Monitoring Project. The objective was to provide the Saint John River Basin Board with sufficient water quality data to develop a multi-use basin plan. Samples were collected biweekly at 29 sites and analyzed for major ions, nutrients, metals, and some pesticides. The following year, the Water Quality Branch initiated its first comprehensive survey for toxic substances by collecting water samples from 126 surface-water sites. The analysis included mercury, cadmium, and selected organochlorine pesticides.

In 1974, the IHD National Water Quality Monitoring Program was replaced by an expanded program called the Water Quality Branch National Water Quality Monitoring Program. This modified network included 77 sites. The data generated by this study included major ions, physical parameters, biological constituents, nutrients, metals, and trace elements.

During the period from 1976 to 1980, 18 studies were undertaken by the Water Quality Branch to investigate the pathways, persistence, and fate of the various pesticides applied to New Brunswick forests to control the spruce budworm. Various pesticides and breakdown products were determined from the 53 sampling sites. These included fenitrothion, aminocarbe, carbaryl, fenitrooxon, aminofenitrothion, and nitroresol.

In 1978, departmental policy and priority changes led to a redirection of Water Quality Branch resource efforts towards boundary waters. In New Brunswick, the WQB National Water Quality Monitoring Program was trimmed to include only 13 core stations, sampled bi-monthly. These strategically selected stations were part of the Atlantic Region Overview Network. During the same year, five new projects were initiated in interjurisdictional waters. These were the International Saint John River Basin Study, the International St. Croix River Study, the Interprovincial Saint John River Study, the Interprovincial Restigouche River Basin Study, and the Dickey-Lincoln School Study. These projects included a network of 21 stations. Their sampling frequency varied depending on the objectives of the particular study.

The Pollutant Specific Survey was the last study to be implemented during the review period. The objective of this study was to screen for specific toxic substances over the entire province, concentrating efforts in areas that were perceived critical or in areas of federal interest. Triplicate sediment or water samples were collected from 18 sites. The 111 samples collected were analyzed for such parameters as pentachlorophenols, chlorobenzenes, mirex, mercury, cadmium, and polynuclear aromatic hydrocarbons.

Over the review period, the Water Quality Branch collected approximately 8000 samples from 210 sites. The analysis of these samples has generated approximately 120 000 data points. These have been stored in NAQUADAT and used for this report.

1.2.2 Provincial Water Quality Programs

Most of the provincial water quality data presented in this report were generated from locations sampled under three main programs: the Baseline Surveys Program, the Assimilative Capacity Program, and the Well Water Improvement Program.

The Baseline Surveys Program was initiated in 1971 with the objective of providing historical and current data on the quality of surface waters throughout the province. Initially, emphasis was placed on recreational lakes, but by the mid-seventies this program was extended to include river systems that were subject to heavy development pressures. The plan called for the repetition of these surveys every five to eight years depending on the water's sensitivity and intensity of use. By the late seventies, approximately 50 major lakes and 8 river systems had been surveyed, and some were in the process of being resurveyed.

The objective of the Assimilative Capacity Program, which was started in 1974, was to determine the levels of contaminants that could be discharged into receiving waters without producing any significant damage to the aquatic environment. One part of this program was to monitor receiving waters both before and after anthropogenic interventions to determine permissible discharge levels. Most of the activities up to 1980 concentrated primarily on measuring the effects of treated domestic wastes and mine waste discharged into receiving waters.

The Well Water Improvement Program consisted of sampling and analyzing private wells, municipal water supplies, and observation wells, and of conducting other special ground-water studies. Sampling of private wells was usually carried out in response to requests from private citizens and normally did not involve more than one sample. Municipal water supplies, on the other hand, were sampled annually.

In order to determine long-term trends in ground-water quality, 20 observation wells were established in the late seventies. These were monitored on a regular basis and provided continuity to the provincial ground-water data. A few special studies were also carried out with the aim of gaining more knowledge of ground-water quality in the province. Examples of these are the determination of nitrate and nitrite in wells located in the agricultural counties of Carleton, Victoria, and Madawaska, and the determination of arsenic in drinking water from the Harvey Station area.

1.2.3 Federal/Provincial Water Quantity Survey Programs

The federal stream gauging program in New Brunswick began in 1916. By 1962, the federal network had expanded to 23 regular, 5 international, 2 powerhouse, and 3 water level stations. This expansion paralleled the increased development activity in the water resources area. The need for the additional water quantity information was propelled by the development of the Saint John River Basin Flood Forecasting Program.

In 1974, a Memorandum of Agreement was signed between the federal and provincial governments. This agreement classifies gauging stations by major responsibility as federal, federal/provincial, or provincial. There were 78 stream gauging stations in operation in New Brunswick in 1980.

Over the years, this network has been expanded and contracted depending on information needs and prevailing economic conditions. The growth of the hydrometric network from 1916 to 1980 is shown in Figure 1.1.

1.3 Field and Analytical Methodologies

Water Quality Branch technicians and Water Resource Branch technicians or trained lay-collectors collected the water samples for all the federal water quality programs. The field methodologies used were documented in Instructions for Taking and Shipping Water Samples for Physical and Chemical Analysis (Water Quality Branch, 1973) and Sampling for Water Quality (Water Quality Branch, 1982). Field activities consisted of sampling from the surface and subsurface of the water bodies and performing some on-site measurements, such as pH and dissolved oxygen. Samples were then preserved and delivered to the Moncton regional office for detailed laboratory analysis.

Water samples were analyzed for a number of different parameters depending on the objective of the particular study (Belliveau and Lockerbie, 1981). The analytical procedures employed are summarized in the NAQUADAT Dictionary (Water Quality Branch, 1980) and described in detail in WQB's Analytical Methods Manual (Water Quality Branch, 1979). Appendix A lists the parameters studied in this report and identifies their appropriate NAQUADAT codes.

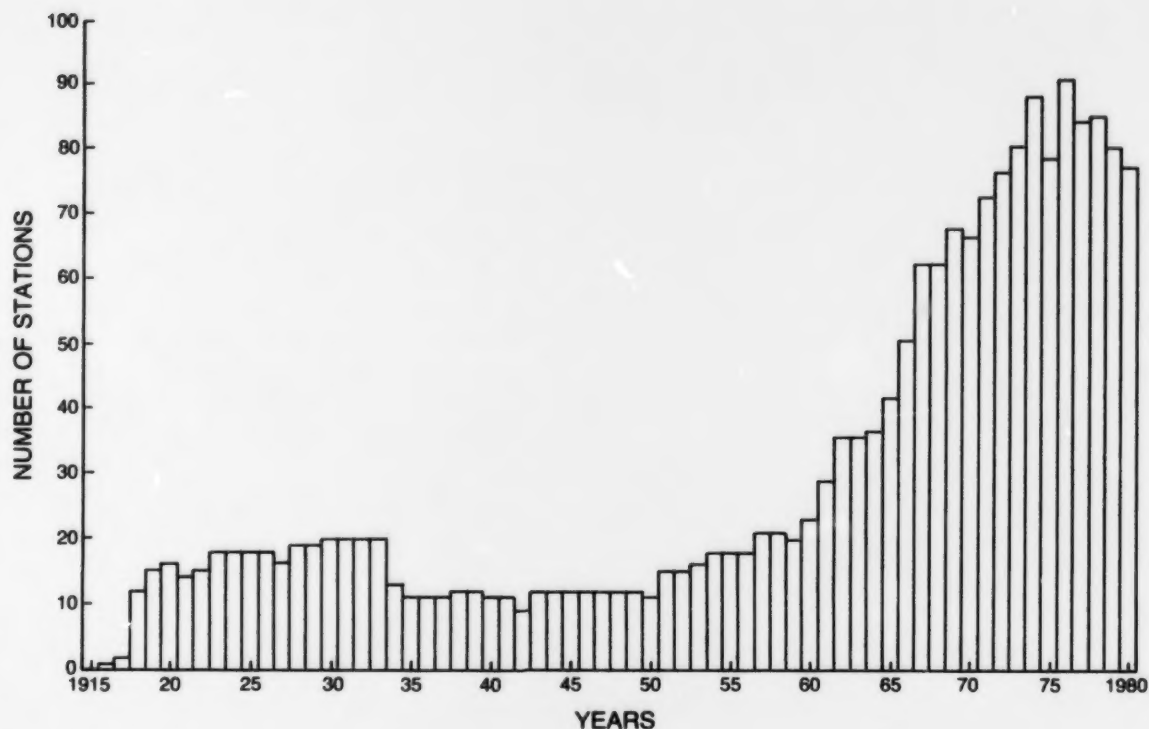


FIGURE 1.1 GROWTH OF HYDROMETRIC NETWORK IN NEW BRUNSWICK(1916-1980)

1.4 The Data Bases

The data bases included the water quality and quantity data from the National Water Quality Data Bank (NAQUADAT) and the provincial water quality and quantity data bases. The screened information from both sources formed a separate file named NBIR (New Brunswick Interpretive Report). This file, along with some corollary files and summary reports contained the surface water and ground-water quality and quantity information used to prepare this study. Other data sources were utilized for information on physiography, geology, hydrology, land uses, and economic activities. All data bases are discussed in detail in the following sections.

1.4.1 Aquatic Data Bases

1.4.1.1 NAQUADAT

NAQUADAT is the computerized National Water Quality Data Bank maintained by the Water Quality Branch, Environment Canada. The system stores chemical, physical, bacteriological, biological, and hydrometric data for surface water, ground water, estuarian waters, precipitation, and sediments (Demayo and Hunt, 1975). NAQUADAT has been operational since 1969 and contains data from 1961 to the present.

1.4.1.2 NBIR Data Base

At the outset, the data from the federal programs were extracted from NAQUADAT, merged with the available provincial water quality data, and then screened to form the NBIR data base. The addition of the provincial data set complemented the federal network information, both spatially and temporally. For surface water, the following screening criteria were applied:

- (a) For each sample, data for a reasonable suite of parameters, typically greater than seven, were required.
- (b) A minimum of five samples at federal sites and four samples at provincial sites had to be available for interpretation.
- (c) Where major ions data were available, the anions and cations had to balance within 10%.
- (d) The geographic location of all stations had to be verifiable.
- (e) Where periods of records at nearby stations were coincident or nearly coincident, only the station with the longest period of record was retained.
- (f) Where several sampling stations existed on the same lake, only the most central station was retained.
- (g) Where several depth samples were taken at one point, only the surface sample was retained.
- (h) After all of the above criteria were applied, the stations were plotted and areas that were grossly overrepresented were "thinned out."

For ground-water stations, slightly different screening criteria were applied because of the different nature of the ground-water data base. The following criteria were employed:

- (a) For each sample, data for a reasonable suite of parameters, typically greater than seven, were required.
- (b) At least two samples had to be available for interpretation at each station.
- (c) Where major ions data were available, anions and cations had to balance within 10%.
- (d) When the major ion chemistry was similar for nearby stations, only one station with that particular water type was retained in the data base.
- (e) Ground-water data were then segregated into three files: shallow (0-45 m), intermediate (46-107 m), and deep (>107 m). Only data from the "shallow" file were incorporated into the main data base itself.

When the above screening criteria were applied, the number of stations in the data base was reduced to a manageable level of approximately 375 surface-water stations and 150 ground-water stations.

Several auxiliary files and summary and detailed data reports were printed from the main data base to assist in the interpretation of special themes. The summary reports contained statistics such as averages and percentiles, while detailed reports listed actual results by date and time.

In addition, existing software packages were used to evaluate the data. The SPSS (Statistical Package for Social Sciences) program was one of them. It provided correlation matrices and scattergrams on a parameter-by-parameter basis for both ground and surface water. The Water Quality Branch noncompliance program was also used. Developed for use in conjunction with NAQUADAT, this program was applied to determine the number of values noncompliant with water quality guidelines for specific uses. Computer programs producing ionic proportion diagrams and trilinear plots were also used.

1.4.1.3 Water Resources Branch Data Base

Hydrometric data are submitted annually by the Atlantic Region on coding sheets as card images on magnetic tape or disks. These data are then stored on one of the four files (SAVE, FLOW, LEVELS, or PEAKS) and printouts are returned to the Region for verification. These data are then processed to automatically produce manuscripts for printing the various publications or are supplied to users on punched cards or magnetic tape for analysis by computer.

1.4.2 Land Use and Physical Resources Data Base

Land use and physical factors influence water quality characteristics. In this report, an attempt has been made to relate land use and physical resource information to water quality.

During the course of preparing for the interpretive phase, a series of thematic maps were prepared. These maps included both provincial and federal resource information ranging from population distribution to reforestation areas. All maps were prepared at a scale of 1:500 000.

In addition to the mapped resource data, access was made to the Canadian Geographic Information System (CGIS) maintained by the Lands Directorate, Environment Canada. The CGIS has information covering the late 1960s and the capability to overlay two or more maps to generate new data bases. This capability was utilized when all third- and fourth-order watersheds were overlain with the land use map of the province. Subsequently, acreages and "percent of total area" values were generated for each land use within each third-order and fourth-order watershed in the province.

Although the information used was not current, this was thought not to be a serious deficiency. The objective of this study was only to develop a generalized picture of major influences, and these influences were not expected to change significantly over the medium term.

In addition, the scale of 1:500 000 is not conducive to precise interpretations of the data. For this reason it is important to regard these maps as illustrative and to interpret them as reflecting only general influences of land uses on water quality.

For the purpose of this study, the interpretation of available resource information was carried out at the third-order watershed level. This level was chosen primarily because it was convenient, but also because it represented the lowest level at which interpretations could be made with any degree of certainty, given the problems discussed above.

1.5 Environmental Setting

For the purpose of this report, the province was divided into seven basins, each encompassing a number of sub-basins. These basins are listed here and shown in Figures 1.2 to 1.9.

- (a) Miramichi River basin (01BM, 01BN, 01BO, 01BP, 01BQ)
- (b) Restigouche River basin (01BA, 01BB, 01BC, 01BE, 01BJ, 01BK)
- (c) upper Saint John River basin (01AD, 01AF, 01AG, 01AH)
- (d) middle Saint John River basin (01AJ, 01AK, 01AL)

- (e) lower Saint John River basin (01AM, 01AN, 01AO, 01AP)
- (f) western coastal basin (01AQ, 01AR)
- (g) eastern coastal basin (01BL, 01BR, 01BS, 01BT, 01BU, 01BV)

The physiography, geology, hydrology, land use, and economic activities typifying the above river basins are discussed in the following sections.

1.5.1 Physiography

New Brunswick is the largest and westernmost of the three maritime provinces. About 60% of the province's 72 520 km² is forested highlands, which reach a maximum elevation of 820 m at Mount Carleton in the Miramichi Highlands. The lowland topography is gentle and rarely exceeds 180 m above sea level. Lakes and estuaries make up 1607 km² of New Brunswick's total surface area.

The physiographic divisions of New Brunswick and adjacent areas of Quebec and Maine, as delineated in the Atlas of Canada (Department of Mines and Technical Surveys, 1957), are shown in Figure 1.10. The principal divisions are the Notre Dame Mountains, the Chaleur Uplands, the New Brunswick Highlands, and the Gulf of St. Lawrence Plain.

The Notre Dame Mountains occupy a small area in extreme northwestern New Brunswick adjacent to the Chaleur Uplands and trending northeast-southwest along the border with Quebec. In New Brunswick, elevations vary between 150 m and 620 m. The rugged surface topography is characterized by numerous lakes.

The Chaleur Uplands are composed of a slightly undulating peneplain in northwestern New Brunswick. The plateau, which rises 300 to 400 m above sea level, is deeply incised by valley tributaries of both the Saint John and Restigouche rivers. A large number of swampy plains and lakes occupy this heavily forested upland area.

Collectively, the Miramichi, St. Croix, and Caledonia highlands form a U-shaped region known as the New Brunswick Highlands. The highlands cover a large part of central and southern New Brunswick, and reach elevations of more than 600 m. Mount Carleton in the Miramichi Highlands is the highest point in the province, attaining an altitude of nearly 820 m above sea level. The ruggedness of New Brunswick's central highlands has resulted from the erosion of weather-resistant rock types of variable hardness. Many rock outcrops exist in the area, and numerous river valleys cut deeply into the landscape.

The New Brunswick Lowland is that portion of the Gulf of St. Lawrence Plain that lies within the province. It is formed by flat to gently dipping sedimentary rocks that are flanked by two arms of the New Brunswick Highlands. Topographic relief is generally below 107 m. The main stem of the Saint John River enters the lowland 16 km upstream from Fredericton. Tributary drainage is received from the Oromocto River, Grand Lake, and Cannan River systems. Poorly developed surface drainage with broad flood plains and gentle river slopes make the New Brunswick Lowland a flood risk area.

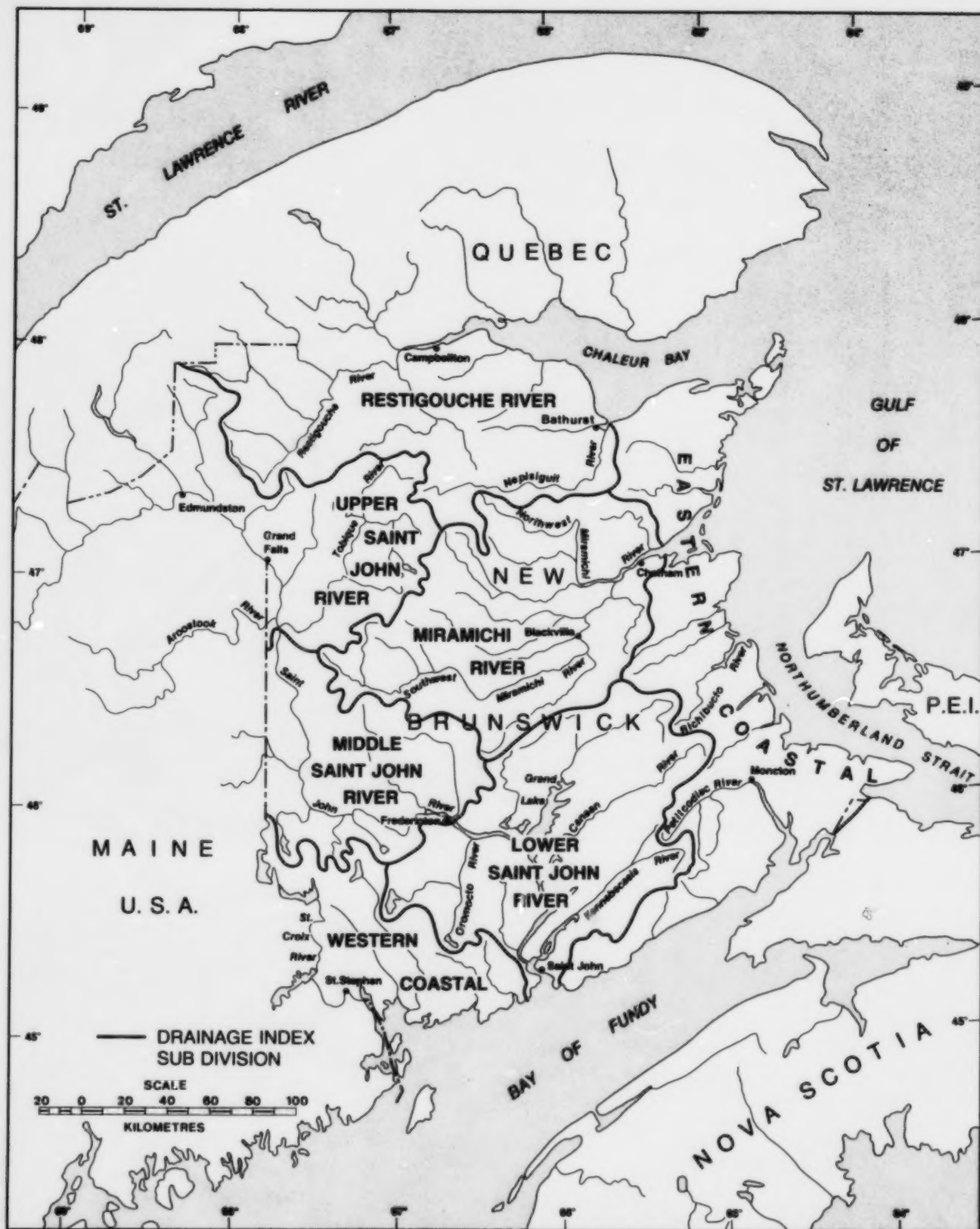


FIGURE 1.2

BASIN MAP OF NEW BRUNSWICK



FIGURE 1.3 MIRAMICHI RIVER BASIN

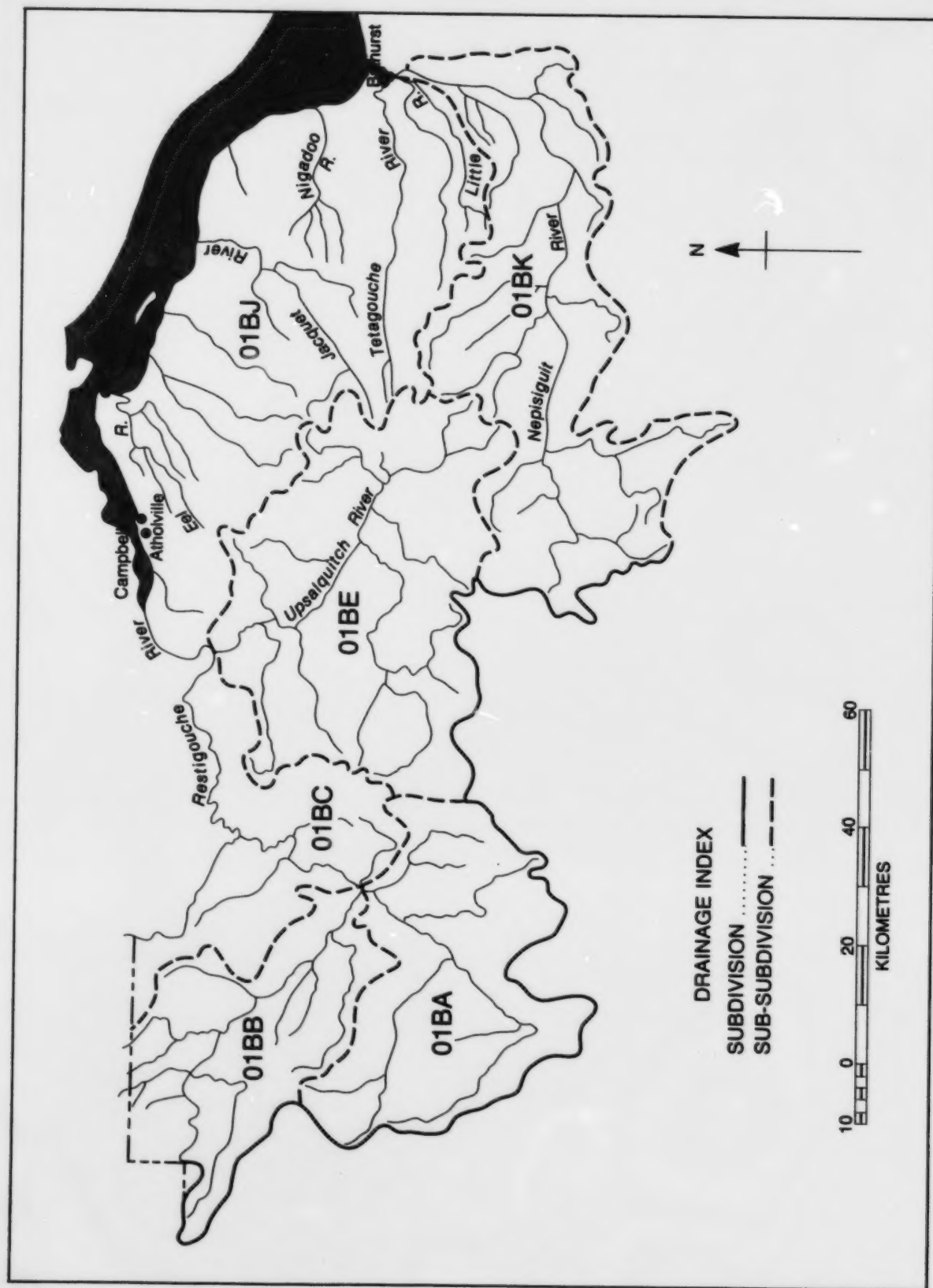


FIGURE 1.4 RESTIGOUCHE RIVER BASIN

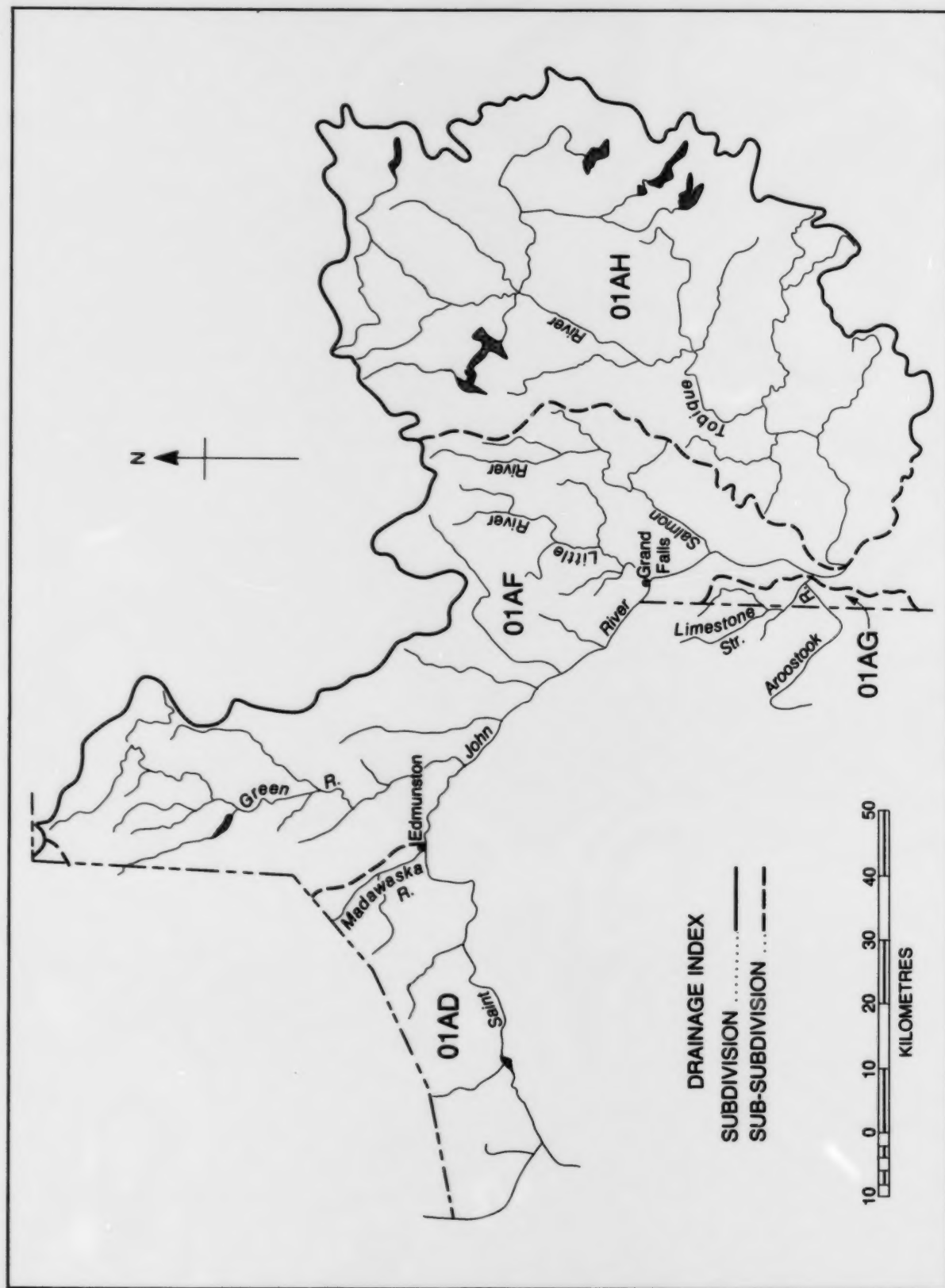


FIGURE 1.5 UPPER SAINT JOHN RIVER BASIN

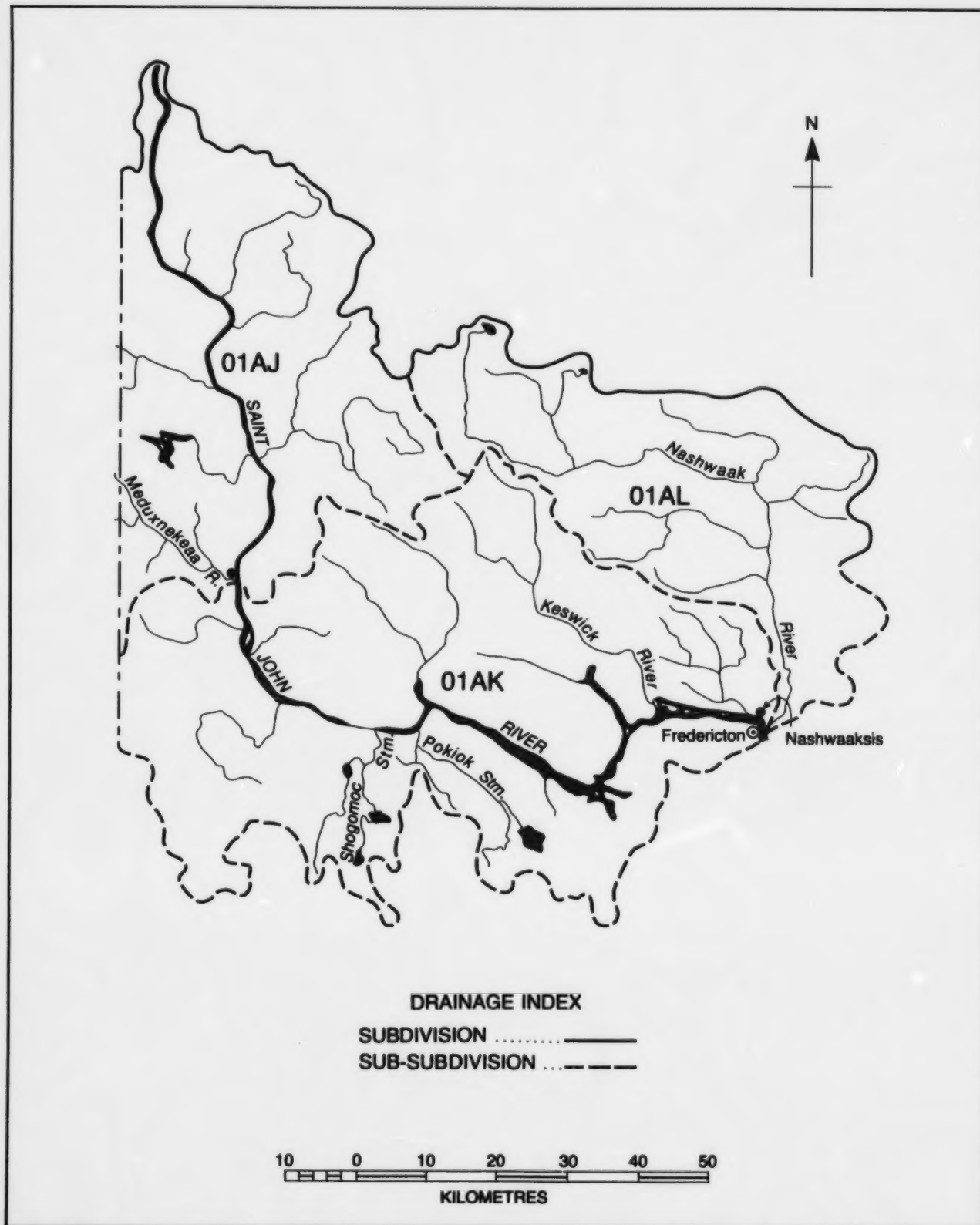


FIGURE 1.6 MIDDLE SAINT JOHN RIVER BASIN

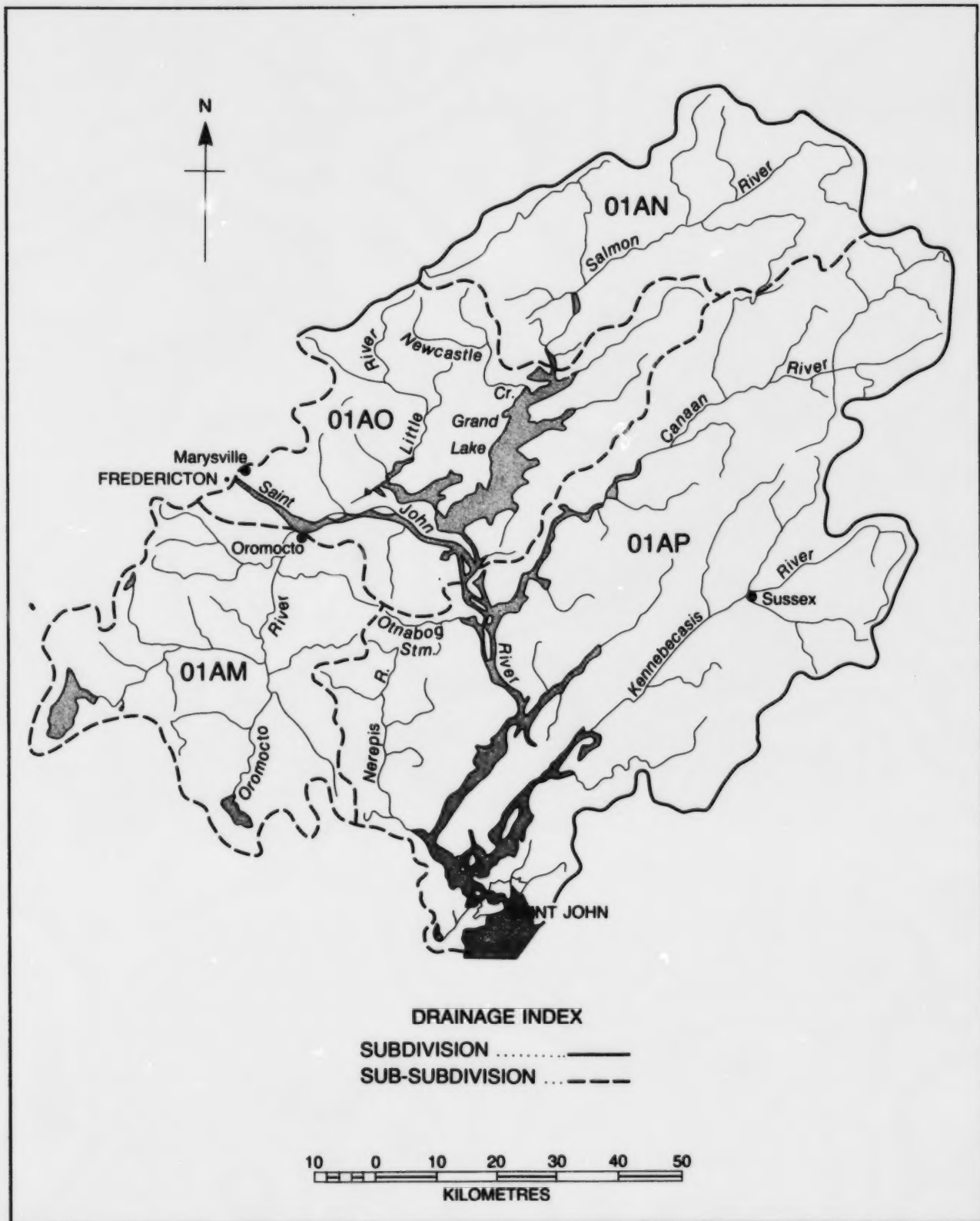


FIGURE 1.7 LOWER SAINT JOHN RIVER BASIN



FIGURE 1.8

WESTERN COASTAL BASIN

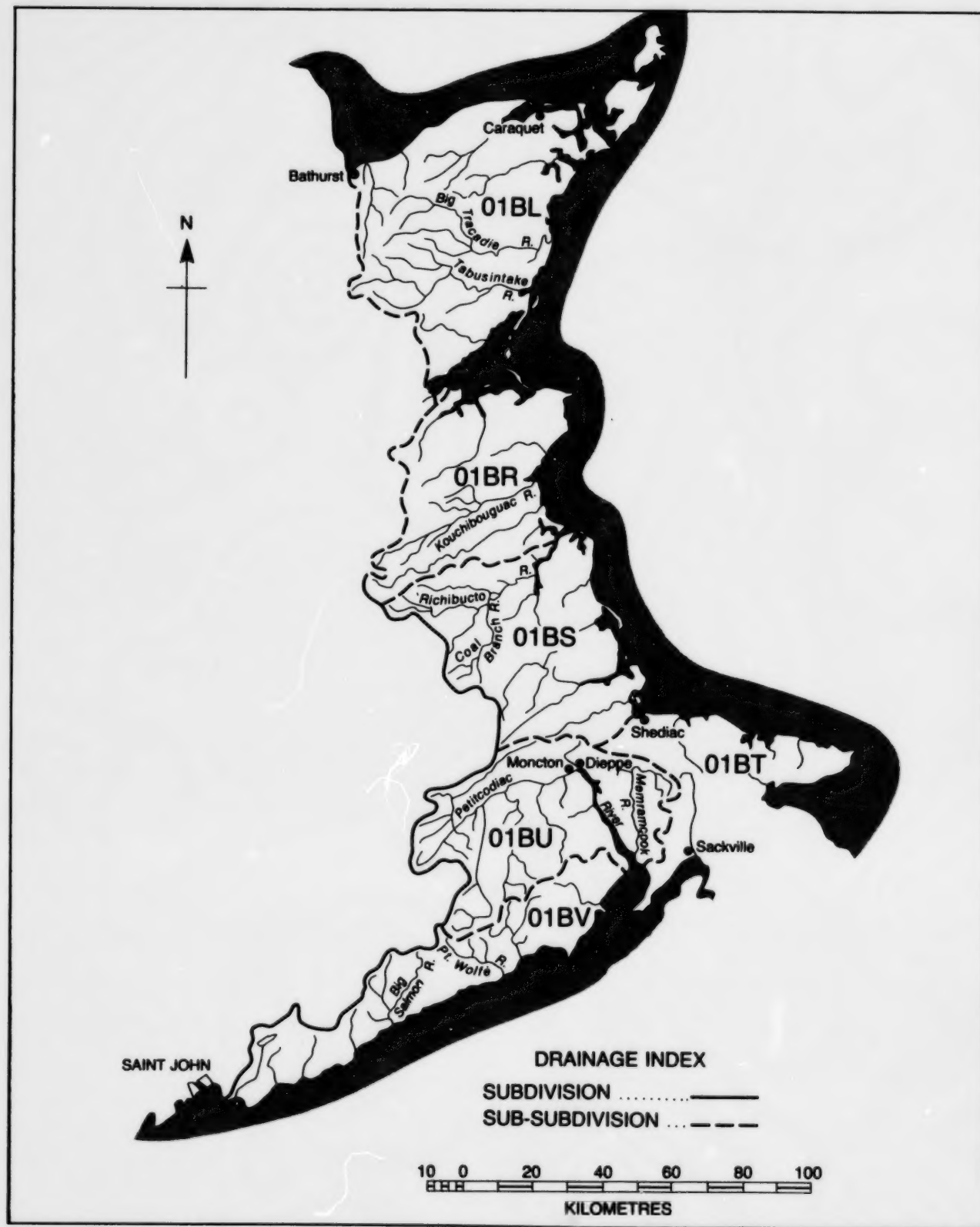


FIGURE 1.9

EASTERN COASTAL BASIN

1.5.2 Geology

1.5.2.1 General Geology

New Brunswick geology is associated with a broad zone of deformed Paleozoic rocks that occupy the former continental Appalachian Geosyncline. This geosynclinal structure extends along the eastern coast of North America from the southwestern United States and possibly beyond to the east coast of Greenland.

Development of minor folds within the larger Appalachian Geosyncline resulted in the formation of the smaller Acadian Geosyncline during Silurian and Devonian times. The Acadian Geosyncline, which for a time covered nearly all of New Brunswick, is reflective of the complex depositional and deformational history of the fold belt.

Pre-Carboniferous sedimentary rocks were deposited in the Acadian Geosyncline and were later faulted, folded, and metamorphosed to varying degrees. The Taconic orogeny and the Acadian orogeny were two of three major orogenic events that greatly influenced bedrock geology throughout New Brunswick. The Maritime disturbance occurred in the Permian, but had comparatively little effect on geology in the province.

In New Brunswick, the Taconic mountain-building episode produced local folding, the intrusion of ultrabasics, and the deposition of sediments in the gradually subsiding Acadian Geosyncline. By the end of the Taconic orogeny, Silurian and Lower Devonian sediments occupied both the Gaspé and Fredericton troughs, which were separated by the Miramichi Geosyncline.

1.5.2.2 Surficial Geology

During the last three glacial periods, many assorted forms of glacial drift were deposited on or adjacent to bedrock surfaces over which glacial ice passed. Earth materials were abraded, ground to fine powder or transported by the glaciers, and sorted and rounded by flowing water. This glacial activity resulted in glacial drift that was extremely heterogeneous.

Glacial drift is composed of three different kinds of materials, the texture and structure of which are usually determined by the mode of deposition. These materials are

- (a) till, the nonsorted, nonstratified debris, typically deposited directly from glaciers;
- (b) ice-contact stratified drift, material partly water-sorted and crudely stratified, deposited adjacent to melting ice; and
- (c) outwash, fluvial sediment deposited away from the melting ice by meltwater streams.

A thin veneer of glacial drift covers most of New Brunswick to a depth rarely exceeding 6 or 7 m and usually ranging between 2 to 4 m. Except for particular cases, the unstratified condition of direct glacial drift, with its high percentage of fines (silt and clay), inhibits water transmission because of low permeabilities.

Ice-contact stratified drift found in highland areas is generally much thinner than deposits layed down in valley areas. Stratified overburden deposits can range from a few centimetres to more than 150 m in thickness, effectively masking preexisting river channels that were locally aggregated with previous sand and gravel materials.

Outwash plains, deltas, and outwash fans having a permeable texture make up some lower valleys. Outwash plains tend to be massive, thick, horizontally bedded deposits formed downstream from the glacier terminus as a result of sediment deposition from overlaid streams issuing from the glacier front. These deposits are well sorted and fragments tend to be washed and rounded. Where glacial outwash and outwash-deltas are traversed by rivers and creeks, they grade from gravel to sand and to other finer forms of alluvium. The surface layer over most of these deposits is commonly silt and fine sand, which is considered a good agricultural soil.

In late glacial and early postglacial times, some areas on the southern and eastern coasts of New Brunswick were submerged to depths of more than 150 m below present-day sea level. Both coasts have sand and gravel glacial-marine deltas at locations where major meltwater streams once discharged into the ocean. Of particular interest are the raised glacial marine deltas on the south coast of New Brunswick between St. George and Saint John.

The undulating to gently rolling topography of New Brunswick's lowland plain has developed poor surface drainage. Numerous creeks, brooks, swamps, and bogs occupy the area that was modified by marine and stream action in late glacial and postglacial times.

New Brunswick's peat moss deposits are among the largest in Canada. They occupy 100 000 ha, 60 000 of which are a measured resource (Laverin, 1946). The Eel River, which drains to the northeast shore, has a bog with an area of more than 6000 ha. Many deposits occur in depressional areas and as narrow bands along small stream channels. The largest bogs occur in groups that follow the New Brunswick Lowland coast from the Miscou lighthouse to Burnt Church and from the Escuminac lighthouse southward. Depths vary from a low of less than 1 m to a high of more than 10 m, while an average of 2 to 3 m is not unusual.

1.5.2.3 Bedrock Geology

(a) Precambrian

New Brunswick is underlain by rocks of Precambrian to Triassic age.

A complex folded and faulted sequence of Precambrian-aged gneiss-limestone-dolomite-quartz and slate outcrops a few miles southwest and southeast of Saint John and on the east side of Grand Manan Island (Potter, 1980). In contrast, Precambrian rhyolitic and andesitic flows, tuffs, and sedimentary rocks are exposed in two subparallel belts southwest and northeast of Saint John.

(b) Cambrian

Small isolated exposures of Cambrian sedimentary rocks occur in the vicinity of Saint John, to the southwest, to the north of the Saint John River, and to the northeast. Red conglomerates and white quartzite occur near the base of the Cambrian. Shales, siltstones, and some limestone predominate in the upper part of the section. Their total thickness is estimated to be 915 m.

(c) Ordovician

Large areas of New Brunswick are underlain by Ordovician rocks of marine origin. They extend from Bathurst in Gloucester County, southwest to Woodstock in Carleton County. In northern New Brunswick, graywackes and slates are overlain by cherty iron formations, thin basaltic flows, and great thicknesses of rhyolitic tuffs and flows.

Carbonaceous slates, quartzites, and minor basaltic flows occur near St. Stephen and Saint John. Only a few graptolites and brachiopods have been found in separate localities over the years.

(d) Silurian

The western, central, and southern parts of New Brunswick are largely underlain by Silurian strata. Folded calcareous and argillaceous sediments occupy the northwestern portion of the province, while volcanic rocks make up the western and northern flank of the Ordovician fold belt.

(e) Devonian

Devonian sedimentary rocks are exclusive to northern and southern New Brunswick. Early Devonian shales occurring in the Chaleur Bay area are overlain by andesitic and basaltic flows, tuffs, and related intrusive rocks. In southern New Brunswick, shales, graywackes, and conglomerates overlie Silurian volcanic strata. Silurian and Devonian rocks appear to be structurally conformable. Shales, sandstones, and volcanic rocks occur with minor conglomerates and are not restricted to the northern and southern parts of the province. Quartz monzonites, associated with granitic batholiths and stocks, are common to the New Brunswick and St. Croix highlands. Quartz diorites, granodiorites, gabbros, and ultramafic rocks occur locally.

Gneissic quartz monzonites and older granitic rocks have been mapped in central and southern New Brunswick, respectively, predating typical Devonian intrusives.

(f) Carboniferous

Upper Devonian and early Mississippian conglomerates occur south of Moncton and are believed to be the same age as those situated near Saint John. Petroleum-bearing shales as well as minor limestone and volcanic rocks overlie the Mississippian and locally occurring Devonian conglomerates.

Early and late Mississippian strata are separated by localized unconformities. The late Mississippian depositional sequence consists of conglomerates, sandstones, limestones, and evaporites.

It is suspected that a large portion of central New Brunswick is underlain by silicic volcanic flows, tuffs, and related intrusive rocks. Representative rhyolitic and andesitic flows occur near Mount Pleasant, on the border between Charlotte and Sunbury counties.

Mississippian evaporites have been separated from Pennsylvanian clastic sediments by local unconformities. The Pennsylvanian stratum, which underlies most of central New Brunswick, is represented at its base by a quartz-pebble conglomerate, which is overlain by relatively thin reddish-brown and grayish-green sandstones.

The bituminous coal deposits of New Brunswick's Minto area are in relatively flat-lying Pennsylvanian stratum, while in contrast, the thin anthracitic coal seams west of Saint John are steeply dipping.

Triassic rocks in New Brunswick have a gentle dip, are slightly consolidated, and consist of bright-red conglomerates, sandstones, and shales. Isolated sedimentary exposures can be found along the Bay of Fundy coast, while mafic volcanic flows, sills, and dykes, containing native copper and zeolites, occur on the west side of Grand Manan Island.

A large number of dykes in northern New Brunswick may be Triassic or younger. A large post-Pennsylvanian dyke extends for more than 100 km, from Sillikers in Northumberland County, northeast to Caraquet on Chaleur Bay.

1.5.3 Hydrological Regimes

The climate in New Brunswick is a modified continental type due to the general movement of air from west to east. The climate is cold in winter and warm in summer, with occasional influxes of Atlantic air creating some mild spells in winter and cool spells in summer.

An isohyetal map of mean annual precipitation for the province is presented in Figure 1.11. The provincial average is 1050 mm a year; however, annual amounts from as little as 400 mm to as much as 1950 mm a year have been recorded at long-term climatological stations.

A narrow strip along the Bay of Fundy (Chaleur Highlands and Caledonia Highlands) can be termed as having a maritime climate. This area is typified by higher mean temperatures, lesser temperature extremes, and 1300 mm (± 100 mm) annual precipitation, which is significantly greater than most of the remainder of the province. The high precipitation is caused by the orographic influence on the moist air moving inland from the ocean.

An average annual precipitation of about 900 mm is distributed over the remaining area of the province, but varies somewhat due to several distinct topographic features. In the highlands and uplands in northwestern New Brunswick and in the lowlands along the eastern coast, precipitation is generally less than 1000 mm. The former area has the heaviest snowfall. In the portion of the lowland plain that extends into the lower Saint John River valley (downstream from the Mactaquac dam), the precipitation is approximately 1100 mm. For the Miramichi Highlands, located in central New Brunswick, precipitation ranges from 1100 to 1200 mm, with local peaks greater than 1200 and, over a small area, as high as 1500 mm.

To the north, where the continental type climate prevails, there is high summer (June to August) and fall (October to November) precipitation and relatively low February to May precipitation. In the southern part of the province, the precipitation is generally higher from September to January and lower in spring and summer (March through August).

In the southwestern part of the province, rain forms a significant portion of the winter precipitation, whereas in the northern parts, less rain and a greater snowfall is common. Even with an abundant mean precipitation, droughts occur in summer and early fall to the extent that crops are affected. The inland areas along the Saint John River and the east coast are the most seriously affected.

The accumulation of snow during winter and its subsequent runoff play a significant part in the hydrology of the province. Snowfall constitutes about 20%-25% of the total annual precipitation in coastal areas and up to 35%-40% in inland highland areas. The bulk of this snow is accumulated during the winter resulting in a large contribution to stream-flows in the spring. Snowfall generally begins in October and peaks around January; it may occur as late as June.

Mean annual snowfall varies from 200 to 250 cm in the St. Croix Uplands (southwest corner of the province) to 350 to 400 cm or more in the Miramichi Highlands. Approximately 100 cm of snowfall equals 100 mm of rain. Figure 1.12 shows the variation of mean annual

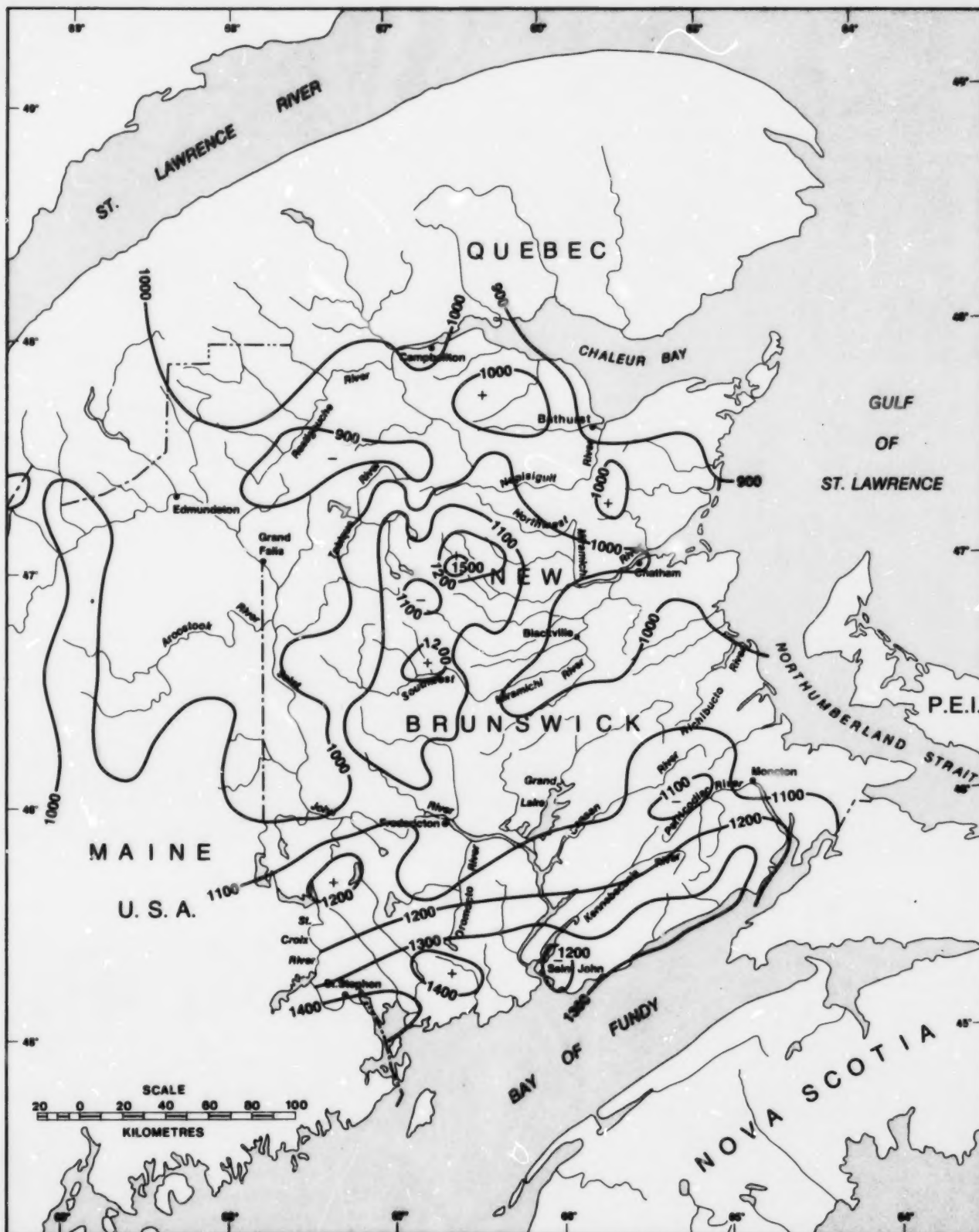
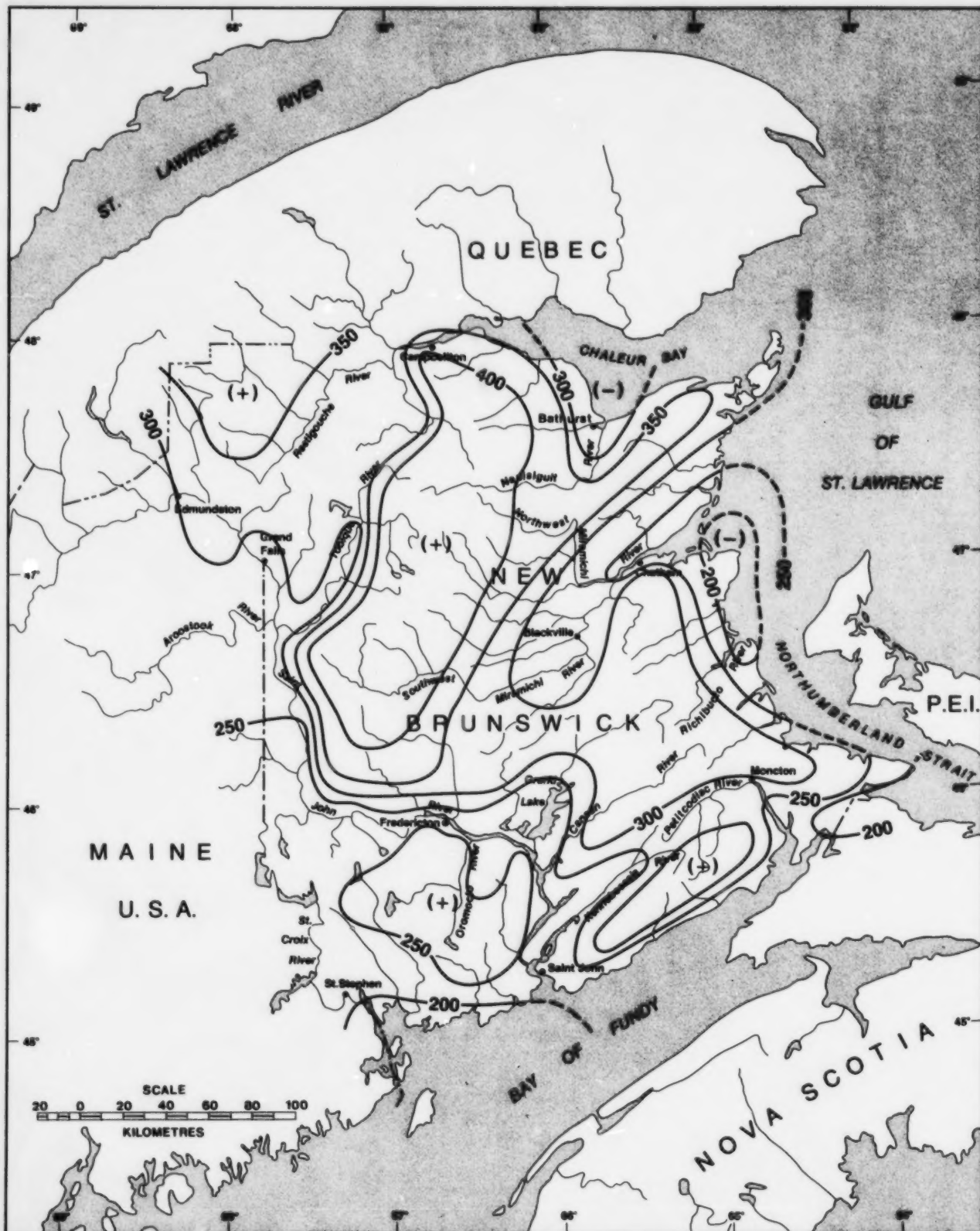


FIGURE 1.11

MEAN ANNUAL TOTAL PRECIPITATION (mm)



SOURCE: "THE TOURISM AND OUTDOOR RECREATION CLIMATE OF THE MARITIME PROVINCES."
A.D. GATES, ATMOSPHERIC ENVIRONMENT SERVICE, TORONTO, 1973.

FIGURE 1.12

MEAN TOTAL ANNUAL SNOWFALL (cm)

snowfall over the province. The coefficient of variation for annual snowfall over the province ranges from roughly 30% along the Bay of Fundy coast and up to Chatham, to 23%-26% in the vicinity of Fredericton and 14%-15% in the northwest corner.

Runoff is generally abundant throughout the province, but marked variations occur. The runoff varies from 1000 mm annually on the south coast to 500 mm along the east corner bordering on the Northumberland Strait. The distribution of mean annual runoff over the province is shown in Figure 1.13.

Peak streamflows occur in April and May, with another high runoff period in October and November. Streams in the southern part of the province have an earlier spring breakup than those in the north. The lowest flows generally occur from January to March and from August to September. The average monthly runoff for the province is shown in Figure 1.14.

1.5.4 Land Use and Economic Activities

1.5.4.1 General

Forests cover 80%-85% of the 72 000-km² area of New Brunswick. The most important industries are those manufacturing industries based on forest resources, followed by agriculture, fisheries, and beverage manufacturing. Raw materials produced include base metals, peat moss, and coal.

1.5.4.2 Demography and Municipal Sewage Treatment Localities

The 1981 estimated population of New Brunswick was 709 100, of which approximately 60% lived in urban centres.

The Miramichi River basin (Fig. 1.3) encompasses an area of 12 300 km² and is the largest basin in the province. Its population is only 6% of the provincial total. Most of the population inhabits the Southwest Miramichi River basin (O1BN) and the Northwest Miramichi River basin (O1BO) near its confluence with the Southwest Miramichi River (O1BN). The other watersheds in the Miramichi River basin (O1BQ, O1BP, and O1BM) are virtually unpopulated, with the exception of O1BM in the area of Juniper. Only two of the six villages in the basin provide central sewage treatment. The major urban areas in this basin, Chatham and Newcastle, provide municipal sewage treatment.

The Restigouche River basin (Fig. 1.4) covers roughly 9360 km² along the northern portion of the province. Virtually all of the population in the basin (11% of the provincial total) is concentrated along the coast of sub-basin O1BJ from Nepisiguit Bay to the mouth of the Restigouche River at the head of Baie d'Escuminac. The main urban areas are part of Bathurst, Campbellton, and the town of Dalhousie; the latter provides municipal sewage treatment. Seven of the 14 villages in the basin provide municipal sewage treatment.

Approximately 46% of the New Brunswick population lives in the Saint John River basin. The majority of the population inhabit the length of the Saint John River, particularly at its confluence with tributaries. Three subdivisions of the Saint John River basin have been categorized as the upper, middle, and lower basins.

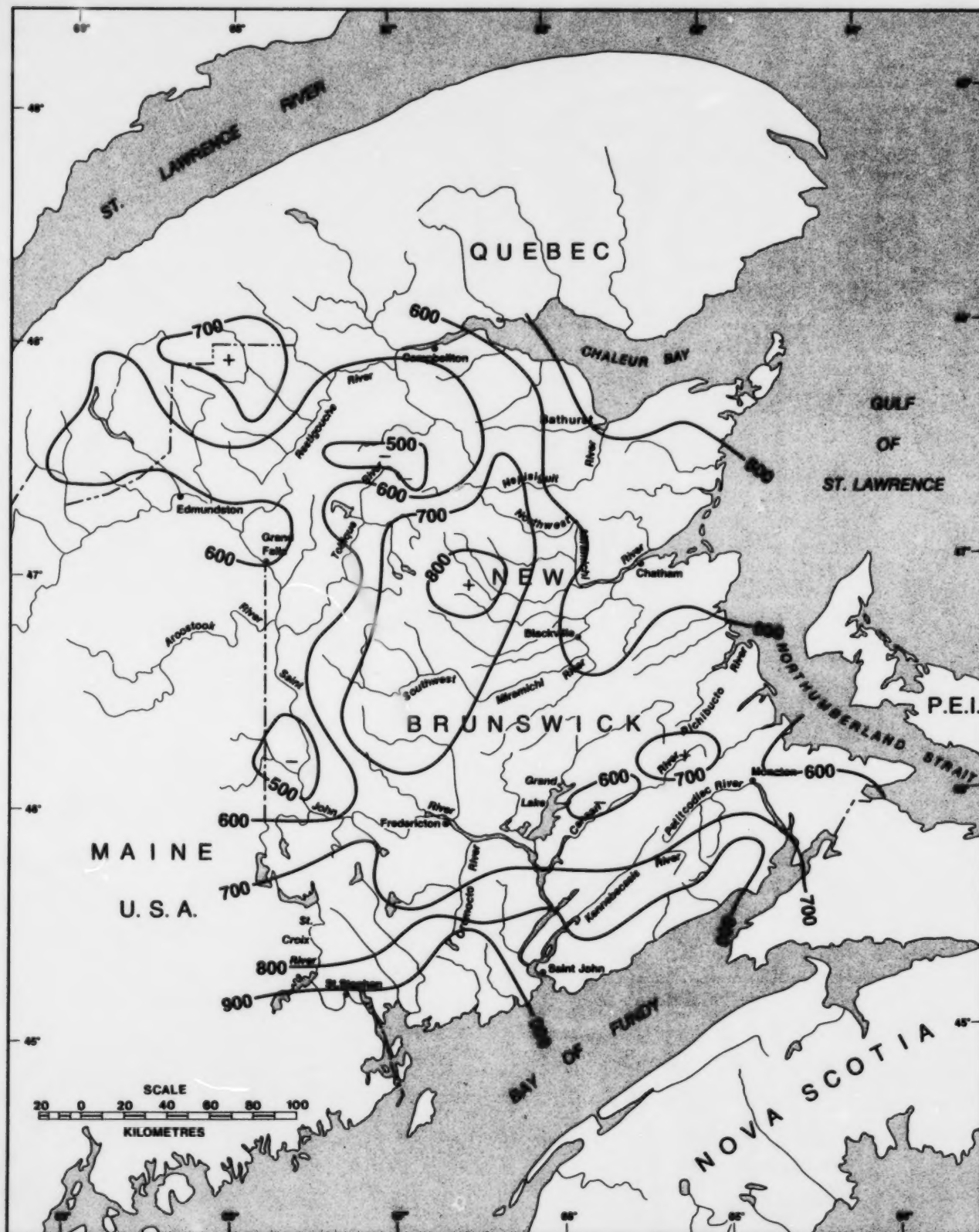


FIGURE 1.13 MEAN ANNUAL RUNOFF (mm)

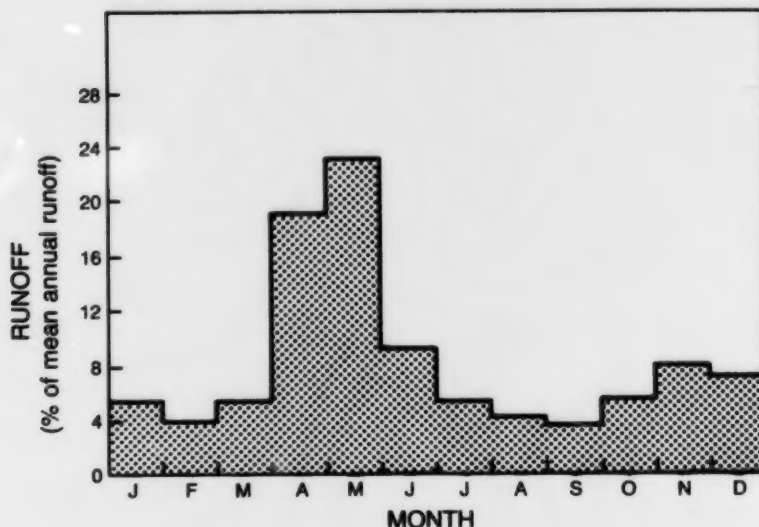


FIG. 1.14 AVERAGE MONTHLY RUNOFF IN NEW BRUNSWICK

The population of the upper Saint John River basin (Fig. 1.5) is 8.5% of the total provincial population. Much of this basin, particularly watershed 01AH and much of 01AF, is unpopulated except along the river. The major urban areas are the city of Edmundston and the towns of Grand Falls and St. Leonard. The latter two provide municipal sewage treatment. Eight of the 15 villages provide central sewage treatment.

The middle Saint John River basin (Fig. 1.6) is one of the more densely populated basins, with 13.4% of the provincial population. The inhabitants are localized along the main stem of the Saint John River and its tributaries, notably the Nashwaak (01AL) and Keswick (01AK) rivers.

Major urban areas located in this basin are portions of the city of Fredericton and its upstream outskirts, and the towns of Hartland (01AJ), Woodstock (01AJ), and Nackawic (01AK), all of which provide municipal sewage treatment. Of the eight villages in the middle basin, only one provides central sewage treatment.

The lower Saint John River basin (Fig. 1.7) is the most heavily populated in the province, consisting of 24.4% of the total population. The inhabitants are concentrated in and around the city of Saint John, located at the mouth of the Saint John River and along the Kennebecasis River. The remaining portion of the city of Fredericton and its downstream outskirts are in this basin. Other urban centres include the towns of Rothesay and Sussex (01AP), Oromocto (01AM, 01AO), and the villages of Chipman and Minto (01AO, 01AN), all of which provide municipal sewage treatment, as do both Fredericton and Saint John. Twelve of the 17 villages have central sewage treatment.

The western coastal basin (Fig. 1.8) consists of approximately 4.4% of the provincial population. Most the inhabitants are in the lower St. Croix River-Passamaquoddy Bay coastal area. The main urban areas are the towns of St. Stephen and St. Andrews (O1AR) and St. George (O1AQ), of which only St. Stephen provides municipal sewage treatment. Central sewage treatment is provided by only one of the five villages in this basin.

The eastern coastal basin (Fig. 1.9) includes both the eastern Fundy sub-basin (O1BU, O1BV) and the eastern coast sub-basin (O1BL, O1BR, O1BS, O1BT). The eastern Fundy sub-basin consists of 15% of the provincial population within an area of approximately 4300 km². Most of the residents live along the Petitcodiac and Memramcook rivers. The major urban areas in this sub-basin are the city of Moncton and the towns of River View and Dieppe. Central sewage treatment is provided by five of the eight villages in this sub-basin. The major urban centres above do not have treatment facilities, but rely on tidal flows.

The eastern coast sub-basin consists of a number of watersheds (O1BL, O1BR, O1BS, O1BT) occupying an area of roughly 9360 km². The population inhabiting this area (17% of the total provincial population) is concentrated along the coast, notably at the estuary areas. Roughly half the population is found within the Acadian Peninsula (O1BL). The urban centres in this area are the eastern portion of the city of Bathurst, the towns of Caraquet, Shippegan, and Tracadie (O1BL), and Shediac and Sackville (O1BT), all of which provide municipal sewage. Nine of the 15 villages in this sub-basin provide central sewage treatment.

1.5.4.3 Generalized Land Use

Productive woodland is by far the most predominant land use in New Brunswick, constituting approximately 76% of land use by area in the province. The activity predominates in all of the basins, ranging from 62% in the eastern coastal basins, to 97% in the Nepisiguit sub-basin (O1BK). In addition to the case of the Nepisiguit, this land use exceeds 80% in the headwaters area of the Miramichi River (O1BM, O1BN, O1BP, O1BQ), the Little Main Restigouche River (O1BA), the Upsalquitch River watershed (O1BE), Charlo and Jacquet river watersheds (O1BJ), the Tobique River drainage (O1AH), as well as in watershed O1AF. In general, productive woodland is more prevalent in the northern and inland basins. No other single land use type constitutes more than 10% of the area.

Improved pasture and forage, nonproductive woodland, and rough grazing and rangeland together constitute 14% of the province. These activities are generally concentrated in the middle and lower Saint John River basins and the eastern coast sub-basin.

Urban land use types include built-up areas, mines, quarries, pits, and outdoor recreation. Mines, quarries, and pits constitute less than 1% of the area. These activities are found mainly in watersheds O1BL and O1AO. Outdoor recreation and built-up areas together form 6% of provincial land use by area. The most widespread built-up area is in the lower Saint John River basin, particularly watershed O1AP.

Swamps, marshes, and bogs constitute roughly 2% of the area of the province. Much of this includes peatlands, notably in the Shippegan area of watershed O1BL, the Bay du Vin to Kouchibouguac area of O1BR, the Sheffield to Grand Lake area of O1AO, and the Oromocto River area of O1AM.

While cropland forms only little more than 1% of the provincial area, virtually all significant expanses of this land use type are found in the upper and middle Saint John river basins, notably the "potato belt" area.

Other land use types in New Brunswick, including orchards, vineyards, horticulture, poultry, and fur operations, as well as unproductive unvegetated land, constitute insignificant amounts of area at the provincial scale.

1.5.4.4 Forest Type and Activity

Forest cover in the Miramichi River basin (Fig. 1.3) is predominantly softwood, with some mixed wood in the centre and small tracts of hardwood in the southwestern part of the basin around Clearwater Brook. Cutover areas are concentrated in the Juniper area in the southwest, the upper reaches of the Little Southwest Miramichi River, and the Bartibog River headwaters. Small patches of burn are found half-way up the Lower North Branch Little Southwest Miramichi River, as well as around the community of Barnaby River and just north of Douglastown. Significant reforestation efforts have been undertaken in the Cains River area (O1BN), as well as some efforts in the Bartibog River headwaters area and limited efforts in other isolated areas through the basin.

The Restigouche River basin (Fig. 1.4) is basically mixed wood with pockets of softwoods and hardwoods. Cutting activity has been mainly in the softwood area (O1BB) and in the headwaters areas of the Upsalquitch, Tetagouche, Jacquet and Charlo rivers. A stretch of cleared area is found along the coast of watershed O1BJ from the Jacquet River to Bathurst, as well as an isolated patch between St. Quentin and Kedgwick (O1BA, O1BC). Some reforestation activity has taken place, mainly in the Charlo River headwaters area of watershed O1BJ.

The Nepisiguit River sub-basin (O1BK) is predominantly softwood with some interspersed mixed wood and hardwood stands, particularly in the Nepisiguit Lakes area. Considerable cutting has taken place throughout the central and downstream portions of the sub-basin. There is a small burn area on the main stem of the Nepisiguit River just north of Heath Steele. Concentrated reforestation activity has been undertaken throughout the lower basin, as well as some efforts in the area north of Nepisiguit Lakes.

The upper Saint John River basin (Fig. 1.5) has a good distribution of softwood, hardwood, and mixed woods. Hardwoods are found primarily in watersheds O1AD and O1AF above Green River and in a stretch between the Salmon and Tobique rivers in O1AH. A large tract of mixed wood is found in the Green-Quisibis-Siegas rivers area, and softwoods are found primarily to the south of the Tobique River in O1AH. Limited cutting activity has taken place in isolated tracts in the northern and eastern portions of the basin. There are cleared areas along the main stem of the Saint John River from Clair, south to below Grand Falls, and along the lower Tobique River. Concentrated reforestation efforts have been undertaken in the First Lake-Green River headwaters area of watershed O1AF. There have also been other isolated efforts.

The middle Saint John River basin (Fig. 1.6) is predominantly mixed wood with scatterings of hardwood and softwood. There are considerable cleared areas along the Saint John River, at the confluence with its tributaries, and particularly in the area west of the river in watershed O1AJ from Upper Kent, south to below Woodstock. Scattered reforestation efforts have been undertaken in the basin, noticeably in the Nashwaak River headwaters area of watershed O1AL.

The lower Saint John River basin (Fig. 1.7) is predominantly mixed wood with tracts of softwood in the Gaspereau and Salmon river areas of watershed O1AN and in the Canaan River area of O1AP. Cutting activity has taken place mainly in the softwood tracts of the Canaan River area. There are considerable stretches of cleared area along the Kennebecasis River and its tributaries in the vicinity of Sussex in watershed O1AP.

There is a large burn area around Lake Stream in O1AN and smaller burns in the vicinity of Bantalor (O1AN) and west of Minto in O1AO. Concentrated reforestation has been undertaken in the Hardwood Ridge-Newcastle Creek area along the northwest edge of Grand Lake in watershed O1AO. There have also been other isolated efforts.

The western coastal basin (Fig. 1.8) is predominantly softwood and mixed wood with small tracts of hardwood in the Grand-Spednic lakes and McAdam areas. Limited cutting activity has taken place, primarily in a lateral tract in the headwaters area of the Magaguadavic and Digdeguash rivers. There is a small burn area just north of Pennfield Ridge. Limited reforestation has been undertaken in the McDougall Lake and Pocologan and New river areas of watershed O1AQ.

The eastern coast sub-basin of the eastern coastal basin (Fig. 1.9) is predominantly softwood with scattered areas of mixed wood particularly in watersheds O1BL and O1BT. There are virtually no hardwood tracts here. Little cutting activity has taken place in this area, although cleared areas are found around Tracadie in O1BL, the Buctouche and Richibucto areas of O1BS, and along the coast of O1BT. There is a major burn area in watershed O1BL in the headwaters area of the Tracadie and Tabusintac rivers, as well as smaller burn areas at the head of the Black River (O1BR), the head of Coal Branch River (O1BS), and on the Tantramar River in O1BT. Significant reforestation efforts have been undertaken in central O1BL in the area of the northern headwaters of the Tabusintac, and in the southern headwaters of the Tracadie River. Other isolated efforts have been carried out in watersheds O1BR and O1BS.

Forest cover in the eastern Fundy sub-basin of the eastern coastal basin (Fig. 1.9) is mainly softwood with tracts of mixed wood in the Loch Lomond area of O1BV and the area surrounding Fundy National Park, and a tract of hardwood in watershed O1BU. Limited cutting activity has taken place here, primarily in an isolated tract in watershed O1BV. There is a cleared area along the upper Petitcodiac River and North River area of watershed O1BU. Limited reforestation has been undertaken in the area just east of Fundy National Park and in central O1BV.

1.5.4.5 Industrial Activity

In addition to extensive utilization of the forest resource base, base metal mining is an important activity in the Miramichi River basin (Fig. 1.3). This mining is concentrated at three locations: Heath Steele, Texas Gulf, and Chester Mines, all within watershed O1BQ. Recreation and tourism, based on Atlantic salmon fishing, is significant here. Agriculture is very limited and is confined mainly to a strip of hay fields along the Southwest Miramichi River. Secondary industry is concentrated in the Chatham-Newcastle area. Industries include chemical products in Chatham and Newcastle, pulp and paper at Newcastle and Nelson-Miramichi, a thermal generating station at Chatham, and industrial parks in both Chatham and Newcastle.

The Restigouche River basin (Fig. 1.4) area depends heavily on forest-based industries centred particularly in the Campbellton-Dalhousie area. The area has a well-reputed sport fishing and wildlife base. Base metal mining is carried out at five locations (Kennco, Nigadoo, Anaconda Caribou, Restigouche, and Brunswick No. 12). Limited agricultural activity is undertaken, primarily in the St. Quentin area. Coastal fish-processing plants are found along the coast of Chaleur Bay in watershed O1BJ. Virtually all secondary industry in the basin is concentrated in this watershed along the coast from Campbellton and Dalhousie down to Bathurst. Industries include chemical products at Dalhousie and Belledune, a smelter at Belledune, a pulp and paper mill and a thermal power plant at Dalhousie, and industrial parks in Atholville and Petit Rocher.

In the Nepisiguit River sub-basin of the Restigouche River basin (Fig. 1.4), industrial activities (except for mining and forestry) are concentrated at the mouth of the Nepisiguit around the city of Bathurst. Base metal mining is being carried out at three locations (Wedge, Brunswick No. 6, and Key Anacon mines). Bathurst has a pulp and paper mill and two industrial parks.

In the upper Saint John River basin (Fig. 1.5), in addition to forestry operations, agriculture and associated food processing are important activities. Water-based recreation potential is high, notably for canoeing and fishing. Industries in the basin include food processing and associated facilities at Grand Falls, St. François-de-Madawaska, and Drummond, a pulp mill at Edmundston; and industrial parks at Clair, Grand Falls, and St. Leonard.

Agriculture, forestry, and associated secondary manufacturing are important industrial activities in the middle Saint John River basin (Fig. 1.6). In fact, a sizable strip on both sides of the Saint John River from Perth-Andover to Hartland is commonly referred to as the New Brunswick "potato belt." There is a significant base metal mining undertaking at Consolidated Durham Mines-Lake George (notably antimony), as well as other smaller active developments in the Pokiok, Shogomoc, and Eel river systems. Water-based recreation is an important activity throughout the basin. Industries include food processing at Florenceville and Hartland, pulp and paper at Nackawic, chemical products at Jacksonville, textiles at Marysville, and industrial parks at Hartland, Woodstock, and Nackawic.

Agriculture, mining, and manufacturing are all important activities in the lower Saint John River basin (Fig. 1.7). The main agricultural areas are within the Kennebecasis River basin and the Maugerville-Sheffield-Jemseg areas. The agricultural products are also processed here. Manufacturing is centred in the Saint John and Sussex areas. Saint John, in fact, is the main centre for secondary industry in New Brunswick. The Nerepis, Hammond, Kennebecasis, and Oromocto river systems, and the Grand and Washademoak lake areas support water-based recreation activities. Industries include coal mining at Salmon Harbour-Midland and Newcastle Creek and an associated coal wash plant near Minto, limestone in the Havelock area, potash exploration and development east of Sussex, a coal-fired thermal station at Newcastle Creek, chemical products (e.g., fertilizers) at Havelock and Brookville, petroleum refining in Saint John, pulp and paper in Saint John, and industrial parks in Fredericton, East Oromocto, Minto, Sussex, Spruce Lake, Grand View, and Saint John.

Industrial activity in the western coastal basin (Fig. 1.8) is mainly resource-based. Secondary industry is light and is focused in the St. Stephen area. Forest harvesting and commercial fishing and processing are the dominant activities. Agriculture is minor and declining. Water-based recreation is significant and widespread, with extensive angling, hunting, and cottage development. Industries include a tin mine at Mount Pleasant, a pulp and paper mill at St. George, wood products at McAdam, a thermal generating station at Coleson Cove, development of a nuclear power plant at Point Lepreau, and an industrial park at Bayside.

Numerous coastal fish-processing plants are found along the stretch of the eastern coastal basin. Other industries include chemical products and a distillery in Richibucto, piggeries and other associated meat processing at Burnsville and Paquetville, silica extraction just east of Bathurst, and industrial parks at Bas-Caraquet and Scoudouc.

The major economic activity in the eastern Fundy sub-basins is forest harvesting. Secondary industry is concentrated in the Moncton area of watershed 01BU. Commercial fishing and agriculture are minor activities. Industries include chemical products at Hillsborough and Moncton, food processing just east of Moncton, the New Brunswick oilfields, and a number of industrial parks around Moncton and Dieppe.

CHAPTER TWO

NATURAL INFLUENCES ON WATER QUALITY

The natural environment exerts a complex array of influences on water resources. New Brunswick's surface and ground waters are influenced by the following factors: geology and physiography, hydrology, and atmosphere. Each of these factors is first discussed in conceptual terms, then a summary of the net effect of all natural influences on water quality is presented.

2.1 Geology and Physiography

Geological and physiographical groupings in the province of New Brunswick influence the existing quality of surface and ground waters. These influences stem from bedrock geology, sediment dissolution, and chemical constituent characteristics. Each grouping is discussed and the resultant water quality of the surface and ground water is described.

2.1.1 Surface-Water Quality

The chemical and physical properties of provincial streams were compared to determine the variety of water types in New Brunswick. These water types reflected the geological groups and physiographic features that occur throughout the province.

The water quality differences observed between the various watershed basins and sub-basins were related, in part, to the bedrock mineral erodibility and the hydrological cycle of the specified areas. These factors have been shown to influence the mineral content of the surface waters in the province.

The chemical quality of surface waters in New Brunswick is generally excellent. Calcium bicarbonate-type waters predominate, although mixed chemical influences have been observed at several locations.

To discuss the quality of surface waters in New Brunswick, sub-basins were grouped together according to similarities in bedrock type. The main bedrock types used were igneous, metamorphic, sedimentary, and mixed origin. The term "mixed" designates the influence of more than one of the three main rock groups. The highland areas of New Brunswick are generally composed of a variety of igneous rocks. The upland areas roughly correspond to metamorphic rock types, largely calcareous and argillaceous in nature. The lowland areas, with the odd minor exceptions, are composed of soft sedimentary rocks.

Several mechanisms contribute to the solute load found in rivers and streams. One such mechanism is the ground-water contribution to increases in the concentration of total dissolved solids (TDS) and most major ions in saturation zones. It has been observed that shallow ground-water in recharge areas is lower in dissolved solids than the water in shallow zones in the discharge area (Freeze and Cherry, 1979).

This phenomenon was observed in the North Nashwaaksis sub-basin (01BL) (Fig. 1.2), a sub-basin situated on a plateau between the larger Keswick and Nashwaak river basins. Charron (1969) concluded that the low specific conductance values observed in the streams of the upper half of the sub-basin indicated that there was no discharge from the sandstone formation typifying the upper half of the basin.

The highlands of New Brunswick include local flow systems that contribute only small amounts of total dissolved solids to streams. Total dissolved solids were consistently higher in streams affected by dissolved calcium originating from the metamorphosed uplands. The base flow derived from intermediate or regional ground-water flow systems contributed greater amounts of dissolved solids to streams in the lowland sedimentary basin. Other sources of total dissolved solids in streams may be derived from the dissolution of sediment by mass wasting or abrasion of the streambed by transported particles or by chemical corrosion.

Almost all of the surface waters in New Brunswick have specific conductance values reflective of low concentrations of total dissolved solids. The specific conductance in the province ranges from 38 $\mu\text{S}/\text{cm}$ in highland (igneous) streams to 71 $\mu\text{S}/\text{cm}$ in lowland (sedimentary) streams. A specific conductance of 59 $\mu\text{S}/\text{cm}$ was reported for streams of mixed geologic influence. The average specific conductance of 144 $\mu\text{S}/\text{cm}$ in upland streams (metamorphic) is nearly twice that of lowland streams and four times that of highland streams.

Alkalinity was reported to be low in non-metamorphic terrain. The lowest average alkalinity approximates 9 mg/L (as CaCO_3) for streams emanating from igneous (highland) terrain. Streams located in sedimentary and mixed terrains have average alkalinity values of 13 and 20 mg/L, respectively. Metamorphic (upland) stream alkalinity values average 55 mg/L. This low buffering capacity is paralleled by pH values slightly below neutral in watersheds composed of sedimentary (pH 6.6), igneous (pH 6.8), and mixed geologic (pH 6.9) influences. The average pH of the moderately buffered upland streams is 7.6. Most of the New Brunswick surface waters have limited buffering capacity and are sensitive to increased acidic inputs, either natural or anthropogenic.

Calcium concentrations can vary according to the availability of alkaline material. The relative lack of calcium from igneous rocks (highland) is indicated by the low average calcium value of 5 mg/L in streams. The opposite is true for the metamorphic (upland) terrain, where the average median calcium concentration in streams is of 23.3 mg/L. Surface waters in the lowland sedimentary basin contain calcium concentrations of approximately 7.0 mg/L, slightly more than the 6.6 mg/L reported for watersheds of mixed geologic influence.

The average "apparent" colour measurements ranged from 13 (Pt-Co units) in the igneous highland streams to 22 (Pt-Co units) in the mixed geologic streams and 54 (Pt-Co units) in lowland streams (MONENCO, 1969).

Turbidity values averaging 1.9 Jackson Turbidity Units (JTUs) were reported for streams overlying soft sediments in the lowlands. The average turbidity value for streams overlying igneous terrain was 1.5 JTUs, lower than 1.8 JTUs reported for streams exposed to mixed geologic influences. The forested nature of highland areas and the less rapid erosion of silicate minerals from igneous rocks are probably responsible for the lower turbidity in streams from these areas. Conversely, the potential for natural erosion of soft sediments, increased runoff from cultivated lands, and the influx of turbidity from human sources is greater in watersheds of mixed geologic influence. Most rivers are likely to show increased colour and turbidity during flood flows, but this depends on the character of the watershed (MONENCO, 1969).

Sulphate concentrations measured in New Brunswick streams show increases from highland to lowland areas. The mean sulphate concentrations of the highlands, uplands, and lowlands were 6.3 mg/L, 8.4 mg/L, and 10.6 mg/L, respectively. Sulphates in surface waters of mixed geologic influence were similar to the metamorphic upland areas.

Sources of sulphate ions in the various physiographic groups stem from the igneous rock minerals of the feldspathoid group in the highlands; the calcium sulphate evaporites such as gypsum and anhydrite in the uplands; and pyrite crystals encrusted in the sedimentary rocks of the lowland areas. These crystals are commonly associated with biogenic deposits such as coal. It has been shown that pyrite oxidation can be a significant source of sulphate as well as hydrogen ions and iron (Hem, 1970). Precipitation also contributes sulphate ions; the annual weighted mean sulphate concentration reported for Atlantic Canada for the period 1977-80 ranged from about 1 to 4.5 µg/L (Barrie and Sirois, 1982).

The mean chloride content of New Brunswick surface waters was higher in lowland streams than in upland or highland streams. The average highland stream chloride concentration was 0.99 mg/L. The average upland stream chloride value was 2.04 mg/L and 1.97 mg/L for streams of mixed influence. Lowland streams had the highest average chloride concentration of 6.6 mg/L.

Chloride is present in all fresh waters, but in surface waters, the Cl^- concentrations are usually lower than sulphate and bicarbonate ion concentrations. Chlorides can enter surface waters from several sources. Rainwater close to the ocean commonly contains from 1.0 mg/L to several tens of milligrams per litre of chloride, but the concentration observed decreases rapidly in a landward direction (Hem, 1970). The feldspathoid sodalite occurs in igneous rocks and frequently chloride crystals may be found within the pores and cracks of igneous rocks. Most authors generally conclude that the largest natural sources of chlorides for fresh waters are sedimentary rocks, particularly marine evaporite sediments and ancient seawater trapped in marine shales.

The geologic source of sodium is the principal factor that determines its concentration in water. The feldspars of igneous rocks are good sources of sodium when weathered. Sedimentary basins commonly retain sodium as evaporites such as halite (NaCl) and thenardite (Na_2SO_4). In resistates, sodium may be present in unaltered mineral grains as an impurity in the cementing material or as crystals of readily soluble sodium salts deposited or left in them by saline water rather than entered at some later time (Hem, 1970).

In New Brunswick, the sodium concentration of surface water from sedimentary basins (5.04 mg/L) is higher than the sodium content of surface waters from igneous basins (2.9 mg/L). Surface waters in the metamorphic (upland) grouping had the lowest average sodium concentration at 2.0 mg/L. Streams in sub-basins of mixed geologic influence had a slightly higher value at 2.4 mg/L.

Magnesium and sodium are major constituents of igneous and sedimentary rocks. Magnesium is readily available for dissolution from geologic materials that form the highlands, uplands, and lowlands of New Brunswick. The surface-water magnesium concentrations were highest in igneous (highland) sub-basins. Upland sub-basins of metamorphic influence had slightly lower (2.4 mg/L) magnesium concentrations. Streams influenced by dissolved sedimentary materials exhibited the lowest magnesium concentration (1.5 mg/L). The mixed sub-basins displayed an uncharacteristically low magnesium concentration of 0.98 mg/L.

In fresh waters, sodium concentrations are often less than the calcium and magnesium concentrations. In New Brunswick surface waters, however, magnesium values were lower than sodium concentrations in streams of igneous, sedimentary, and mixed influences. Calcium concentrations remained consistently higher than sodium concentrations in streams from all sub-basins. Magnesium concentrations in most natural fresh water are lower than calcium levels.

2.1.2 Ground-Water Quality

The quality of ground water is, in general, determined by the geochemical makeup of the earth material in contact with the ground water and the length of time of contact. Parametric concentration may be explained by the bedrock geology.

2.1.2.1 Mississippian

The available ground-water quality data from water in Mississippian bedrock in New Brunswick is inadequate to determine trends. The Mississippian group bedrock, however, typically contains evaporites. Evaporites have been shown to contribute total dissolved solids and hardness, depending on the nature of the evaporite. The Windsor group of Mississippian age in Nova Scotia often shows these characteristics (Gibb and McMullin, 1980; Vaughan and Somers, 1980; Trescott, 1969).

2.1.2.2 Pennsylvanian

Ground water in the Pennsylvanian group can be of variable quality. The trilinear plot in Figure 2.1 illustrates the range of water types encountered. These are further illustrated by the ionic proportion plots of selected stations in Figure 2.2. (Refer to sections 2.4.3 and 2.4.4 for ionic proportion and trilinear plot descriptions, respectively.) In Figure 2.1, there is an indication the majority of ground waters were of the bicarbonate type, approximately equally divided between calcium and sodium cation predominant. Some chloride, a few sulphate predominant, and some waters not clearly defined make up the rest.

Ground waters ranged from very soft (7 mg/L in sub-basin 01BS) to very hard (820 mg/L in sub-basin 01A0). The majority of stations reported waters in the moderately soft range (61-120 mg/L). All median values of pH were greater than 6, and at approximately 90% of the stations in the Pennsylvanian, were greater than 7.0. The highest reported median pH value was 9.5. Alkalinity, mainly bicarbonate, ranged in median values from 35 to 269 mg/L. The lower values tend to reflect less mineralized waters.

Total dissolved solids, as indicated by specific conductance, is variable throughout ground waters in the Pennsylvanian bedrock region. Median values range from 78 to 2200 $\mu\text{S}/\text{cm}$. The latter is probably associated with naturally occurring saline ground waters. The conductance values were less than 500 $\mu\text{S}/\text{cm}$, or total dissolved solids about 300 mg/L, in most of the sub-basins.

Iron and manganese problems are fairly common in ground waters of the Carboniferous basin (Fig. 2.3) and have been reported in northern Nova Scotia by Vaughan and Somers (1980), Gibb and McMullin (1980), and Cross and Rushtin (1976); in Prince Edward Island by the Inland Waters Directorate (1981); and by various authors in New Brunswick (New Brunswick Environment, 1976, 1979, 1980; MONENCO, 1978). Very high iron and manganese levels were measured (iron >10 mg/L and manganese >5.0 mg/L) in areas of old coal mine workings or coal measures. Ground waters under such conditions often contained, in addition to high iron and manganese, high ammonia (e.g., >1.0 mg/L) and a strong hydrogen sulphide odour (New Brunswick Environment, 1980).

Elevated fluoride levels have been noted in ground waters of the Carboniferous basin for some time. Carr (1968a) reported fluoride values as high as 5.7 mg/L in the Moncton area. Lamoreaux (1948) suggested three possible major natural sources of fluoride in ground water: seawater trapped at the time of original deposition, volcanic emanations, and the weathering of fluoride-bearing minerals such as fluoride and apatite.

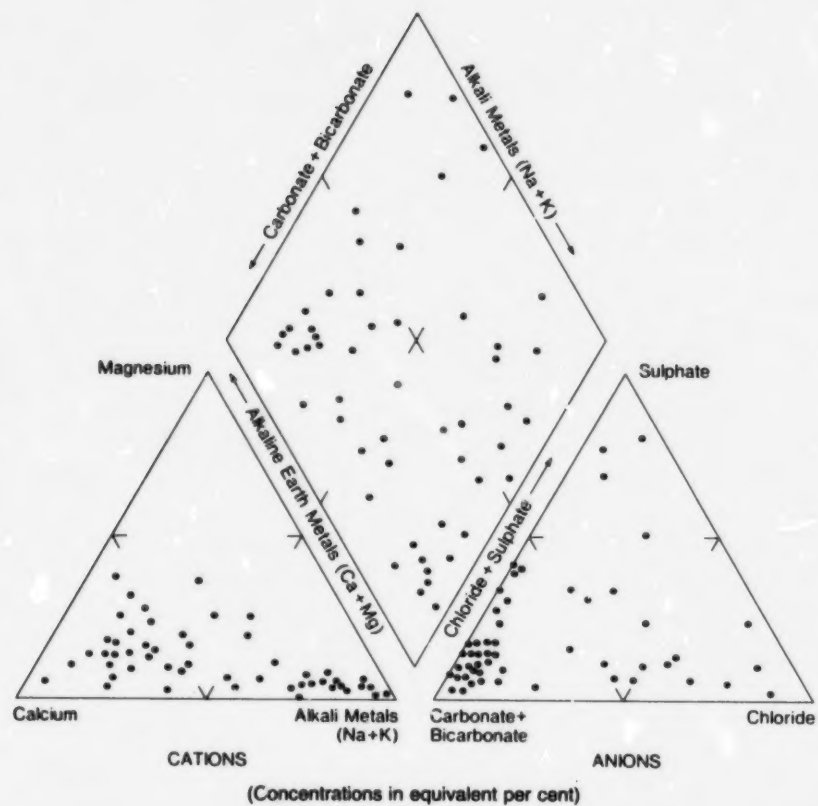


FIGURE 2.1 TRILINEAR PLOT OF MAJOR IONS AT STATIONS IN PENNSYLVANIAN BEDROCK

SODIUM CHLORIDE



10BR01AO0106

NO DOMINANT CATION



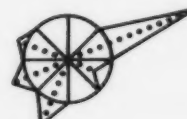
10BR01BL0090

SODIUM BICARBONATE



10BR01BU0063

NO DOMINANT ANION



10BR01AL0021

CALCIUM BICARBONATE



10BR01BN0024

MIXED



10BR01AL0015

CALCIUM SULPHATE



10BR01AO0081

**FIGURE 2.2 IONIC PROPORTION DIAGRAMS OF SELECTED STATIONS
IN PENNSYLVANIAN BEDROCK**

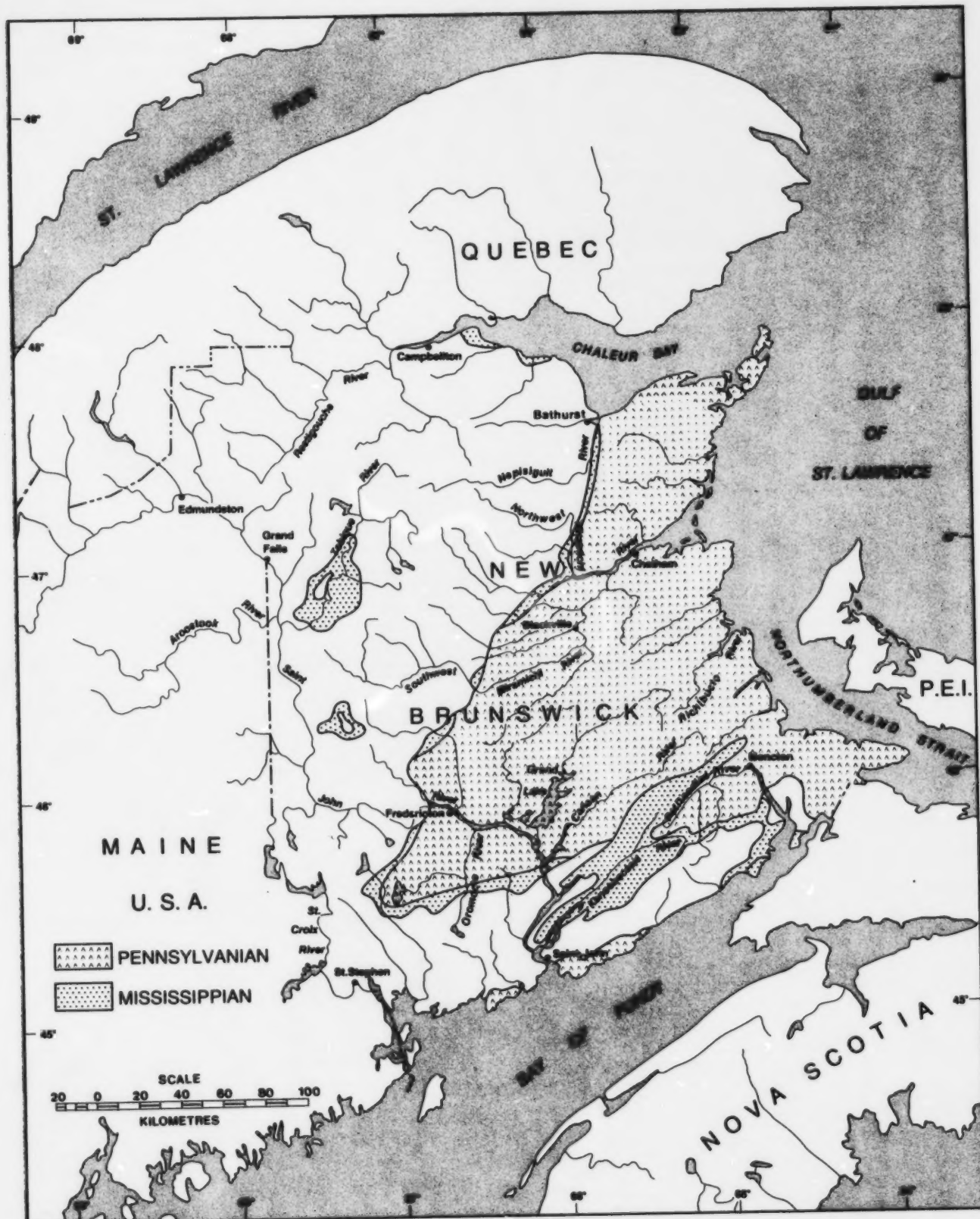


FIGURE 2.3 DISTRIBUTION OF CARBONIFEROUS ROCKS

A number of conditions are associated with high fluoride ground waters. The most commonly reported geochemical conditions are high bicarbonate concentrations, high pHs, and high Na/Ca ratios. Membrane effects could possibly contribute to these observed conditions. White (1965) and Van Everdingen (1968) noted that the low pressure side of the membrane generally has a pH concentration of >7.0, higher fluoride, and a higher Na/Ca ratio than on the high pressure side. Several authors have noted that fluoride tends to be higher in deeper wells. This trend is shown in Figure 2.4. Table 2.1 provides examples of NAQUADAT stations reporting high fluoride. The conditions of pH >7.0, high Na/Ca ratios, and high bicarbonate concentrations prevail.

Table 2.1. Selected Parameters of Various NAQUADAT Stations with High Fluoride Concentrations

Station	Fluoride (mg/L)			Na/Ca ratio (medians)	Total alkalinity (as mg/L CaCO ₃)			pH		
	Low	Med.	High		Low	Med.	High	Low	Med.	High
01AD0191	4.60	4.60	5.3	7.3	-	172	-	8.3	8.6	8.9
01BD0135	0.10	1.20	2.3	8.0	-	217	-	8.0	8.6	8.6
01B00143	0.16	1.93	3.7	9.1	61	80	100	8.0	8.1	8.2
01BU0008	3.50	4.00	7.6	29.0	295	311	312	8.4	8.6	8.7

2.1.3 Saline Ground Water

The occurrence of highly mineralized ground water has been reported from several areas in the Carboniferous bedrock of the maritime provinces. These occurrences have been related to seawater intrusion, evaporite deposits, highly mineralized connate waters (waters trapped at the time of sediment deposition), and brines or brackish waters formed by various phenomena, such as membrane effects (Freeze and Cherry, 1979). The anthropogenic effects of road deicing salt application and storage will not be discussed in this section.

2.1.3.1 Seawater Intrusion

Seawater intrusion is a potential problem in all coastal or estuarine areas. In New Brunswick, seawater intrusion into Carboniferous bedrock has been documented in several areas. In northeastern New Brunswick along the Chaleur Bay and Gulf of St. Lawrence coasts, seawater intrusion problems have been reported as being "not uncommon" (New Brunswick Environment, 1979).

Seawater intrusion is especially severe in the Shippegan-Lamèque area, and a considerable amount of study has gone into this problem (New Brunswick Environment, 1979; Carr, 1968b; Lazreg, 1972). Seawater intrusion has also been identified in the Chatham area (New Brunswick Environment, 1976; Lazreg, 1974) and in the Kouchibouguac National Park (MONENCO, 1978). Seawater may be affecting ground-water quality in the Moncton area (Carr, 1968a).

In Chatham, Well #12 (station 01B00026) was indicative of seawater intrusion. The median value for sodium was 191.5 mg/L, for calcium 118.6 mg/L, magnesium 58.1 mg/L, bicarbonate 120 mg/L, chloride 518 mg/L, and sulphate 40.7 mg/L. New Brunswick Environment (1976) concluded that the source of the saltwater problems in the Chatham area appear to be both seawater intrusion and the up-coning of deep-seated saltwater.

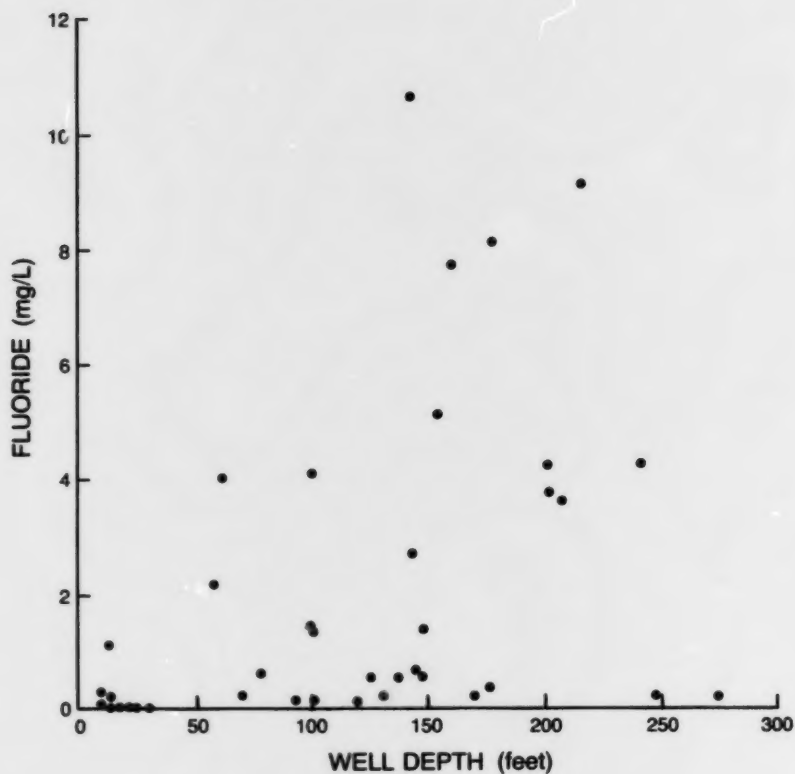


FIGURE 2.4 FLUORIDE AS RELATED TO WELL DEPTH
(AFTER CROSS AND RUSHTIN, 1976)

2.1.3.2 Other Saline Ground Waters

Highly saline ground waters that cannot be attributed to seawater intrusion have been reported from several areas of the Carboniferous in New Brunswick and Nova Scotia. In many cases, these mineralized ground waters are directly attributable to evaporites such as gypsum or anhydrite, which are composed essentially of calcium sulphate. As a result, these waters tend to exhibit a mainly calcium sulphate composition and are very hard and have high total dissolved solids concentrations. Carr (1968a) reports ground-water quality affected by gypsum in the Irishtown area, north of Moncton.

Saline waters in some wells, generally over 30 m (100 ft.) deep, occur in a large area including Plaster Rock, Fredericton, Tracy, Oromocto, and Chipman (Fig. 2.5). Evaporites occur in the Plaster Rock area, however, much of the remaining areas outlined above are underlain by Pennsylvanian bedrock, with no known occurrence of evaporites. The existence of natural brines, unrelated to evaporites, are commonly encountered in deep petroleum exploration (Freeze and Cherry, 1979). Connate waters may be squeezed out of the sediments along zones of higher permeability (Noble, 1963). White (1968) and Noble (1963) felt that such a process was significant in the formation of certain ore deposits such as lead, copper, and zinc. These saline ground waters may be meteoric (originated at the ground surface from precipitation), but are very old and slow-circulating.

Ground water evolves from a predominant bicarbonate type through sulphate predominating and finally chloride. The chloride predominant type of ground water would be expected from deep zones with very sluggish ground-water movement. These waters could emerge at shallow depths by the effects of tectonic activity or erosional processes.

Another theory is the membrane effect. This is a reverse osmosis effect naturally occurring in deep sedimentary basins. Ground water is forced under pressure across a semipermeable membrane, which is composed of highly compacted clay strata. The membrane restricts the passage of certain ions causing an increase in solute concentration on the input side of the membrane. This process is also called salt filtering, ultrafiltration, or hyperfiltration. A summary description of this process is provided by Freeze and Cherry (1979). The effective stress required in order for the process to work cannot be achieved at depths of less than 500–1000 m (1600–3200 ft.). As in the case of waters described by the Chebotarev Sequence, however, tectonism and erosion could cause the appearance of these waters at shallower depths.

Examples of ground waters that may be affected by formation salt were found in stations 10BR01BU0008, 10BR01BU0055, and 10BR01BU0059. Concentrations of selected parameters are given in Table 2.2. These samples are characterized in Figure 2.6, the trilinear plot, and Figure 2.7, the ionic proportion diagrams. These stations are located in the general area of known salt deposits. The salts encountered in this area include calcite (CaCO_3), dolomite ($\text{CaMg}(\text{CO}_3)_2$), gypsum ($\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$), anhydrite (CaSO_4), glauberite ($\text{Na}_2\text{Ca}(\text{SO}_4)_2$), halite (NaCl), and probably many others (Hamilton, 1961). Therefore, ground water in such areas could be of variable composition. Station 10BR01BU0008 was sulphate predominant, and stations 10BR01BU0055 and 10BR01BU0059 were chloride type. Sodium and potassium predominated in stations 10BR01BU0008 and 10BR01BU0059, and calcium predominated in station 10BR01BU0055.



FIGURE 2.5 SALINE GROUND WATERS

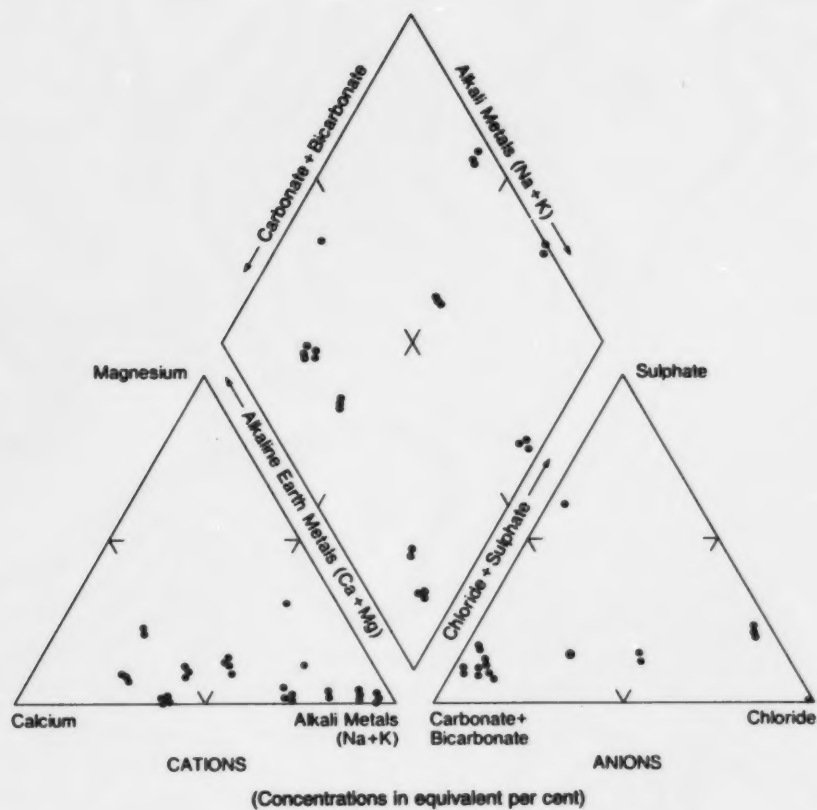


FIGURE 2.6 TRILINEAR PLOTS SHOWING STATIONS AFFECTED BY FORMATION SALT

Evidence of ground waters affected by sources of saline waters not readily attributable to formation salt or seawater intrusion are given in Table 2.3. Sodium was the dominating cation at stations 10BR01A#0189, 10BR01A#0080, 10BR01A#0106, and 10BR01A#0107. Chloride was the dominating anion at stations 10BR01A#0109 and 10BR01A#0106. Bicarbonate was slightly dominant at 10BR01A#0107, while there was no dominant anion at 10BR01A#0080. Station 10BR01A#0081 exhibited a composition strongly influenced by calcium and sulphate.

This may indicate the influence of gypsum or anhydrite. Evaporite occurrences have not been reported from the area of station 10BR01A#0081, although there may be local occurrences.

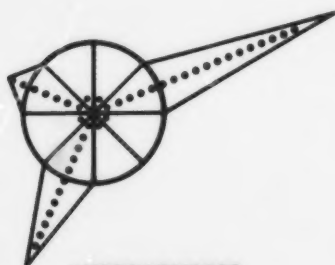
Table 2.2. Concentrations (mg/L)* of Selected Parameters of Samples from Stations 10BR01BU0008, 10BR01BU0055, and 10BR01BU0059

Station #	Na ⁺	Ca ⁺⁺	Mg ⁺⁺	Cl ⁻	SO ₄ ⁼	HCO ₃ ⁻
10BR01BU0008	320	11.2	—	27.2	458	311
10BR01BU0055	329	460	5.8	802.8	338	70†
10BR01BU0059	3170	1100	28	7500	34	1.0

*Median values.

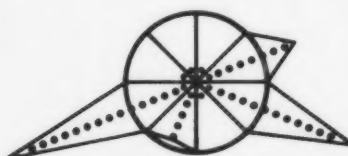
†This value is total alkalinity

SALINITY = 80.40 meq/L (epm)



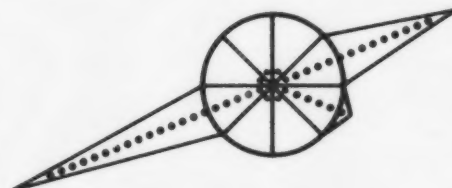
10BR01BU0008

SALINITY = 68.92 meq/L (epm)



10BR01BU0055

SALINITY = 40.80 meq/L (epm)



10BR01BU0059

FIGURE 2.7 IONIC PROPORTION DIAGRAMS OF THREE STATIONS INDICATING WATER QUALITY AFFECTED BY FORMATION SALT

Table 2.3. High and Median Values of Selected Parameters at Stations Influenced by Saline Ground Waters

Station		Na ⁺	Ca ⁺⁺	Mg ⁺⁺	Cl ⁻	SO ₄ ²⁻	HCO ₃ ⁻
10BR01A#0189	high	320	110	1.8	600	73	293
	median	235	70.5	1.8	380	52.5	293
10BR01A#0080	high	280	5.0	0.9	530	200	190
	median	175	3.9	0.62	84	140	183
10BR01A#0081	high	260	600	8	210	1400	--
	median	183	565	7.5	200	1300	--
10BR01A#0106	high	400	99	1.4	800	6.6	76
	median	214	53.6	1.3	409	--	--
10BR01A#0107	high	180	47	0.67	270	29	156
	median	110	14	0.26	81	28	154

2.2 Hydrology

The hydrological regime is a major determining factor in the quality of surface waters. When streamflows increase, the concentrations of dissolved constituents, such as alkalinity, hardness, and minerals, generally decrease and vice versa. The streamflow increases are caused by rainfall, the resultant runoff, or snowmelt. When snowpacks melt, the first part of the meltwater is often highly rich with ions, which come primarily from the atmosphere. This can result in significant increases in the concentrations in streams of such ions as Na⁺, Cl⁻, SO₄²⁻, H⁺, NH₄⁺, and NO₃⁻. The quality of precipitation falling in the form of rain and the respective overland runoff also significantly affect surface-water quality.

The magnitude of the effects on the concentrations of chemical constituents will depend on a number of factors including the geologic features of the drainage basin; the make-up of the surficial and bedrock materials and their buffering capacities; the physiography of the basin, including land slopes and the existence of swamps, bogs, and lakes; the amount, age, and condition of the snowpack; and the chemistry of the rainfall or snowfall.

Most of the water in a stream at low flows has spent much time underground in intimate contact with the minerals of the soil and has dissolved maximum amounts of these minerals. At least some of the water at times of high flows has run off directly over the surface of the ground, and some of it has been underground a relatively short time with less opportunity to dissolve minerals. Table 2.4, containing an analysis of water quality data for 146 samples collected on the Saint John River at Clair between July 1971 and December 1973, supports this. The table indicates that alkalinity varies inversely with streamflows. Maximum concentrations occur after a time of sustained baseflow recession, such as in the period from November 1971 to February 1972. Sudden increases in direct or subsurface runoff reduced the proportion of the streamflow produced by long-term water residency in the ground and hence reduced total alkalinity.

Table 2.4. Comparison of Selected Water Quality Constituents with Streamflow for the Saint John River at Clair, New Brunswick, 01NB01AD0001

Month	Year	Discharge (m ³ /s)	Total Alkalinity (mg/L as CaCO ₃)	Calcium (Dissolved) (mg/L as Ca ⁺⁺)	Magnesium (Dissolved) (mg/L as Mg ⁺)	Total Dissolved Solids (mg/L)
July	1971	92.4	27.2	11.2	1.5	40
Aug.	1971	279	22.3	10.1	1.4	39
Sept.	1971	313	20.5	9.6	1.2	34
Oct.	1971	188	21.4	9.3	1.2	34
Nov.	1971	82.1	31.0	11.5	1.5	41
Dec.	1971	63.9	29.8	11.7	1.6	42
Jan.	1972	49.4	30.7	11.2	<u>1.9</u>	43
Feb.	1972	39.4	<u>34.0</u>	<u>13.3</u>	1.8	<u>49</u>
Mar.	1972	82.1	26.6	11.8	1.5	42
Apr.	1972	292	20.5	9.4	1.2	35
May	1972	<u>1580</u>	14.1	6.5	0.9	25
June	1972	363	16.7	7.9	0.9	28
July	1972	252	19.7	8.8	1.2	32
Aug.	1972	276	19.4	8.8	1.2	32
Sept.	1972	224	25.5	10.6	1.4	37
Oct.	1972	287	21.3	9.4	1.2	34
Nov.	1972	255	21.0	9.3	1.3	33
Dec.	1972	141	32.4	13.2	1.3	44
Jan.	1973	125	31.9	10.2	1.4	<u>49</u>
Feb.	1973	212	21.0	9.2	1.3	<u>34</u>
Mar.	1973	282	19.8	9.1	1.2	35
Apr.	1973	1240	14.5	7.9	1.0	32
May	1973	1180	13.4	6.3	0.8	23
June	1973	329	21.5	8.7	1.1	32
July	1973	134	25.9	10.5	1.3	37
Aug.	1973	147	29.0	12.4	1.4	42
Sept.	1973	126	22.3	9.8	1.4	38
Oct.	1973	131	22.8	9.9	1.3	37
Nov.	1973	80.4	22.8	10.6	1.4	39
Dec.	1973	330	17.8	8.8	1.3	34

Note: Underlining indicates highest value.

The fact that alkalinity does not decrease linearly with the increase in streamflow indicates that either baseflows were severely underestimated by conventional hydrograph separation techniques or, more likely, the surface and interflow runoff components, collectively called direct runoff, contain significant alkalinity (e.g., sediment wash-off and erosion).

For the Saint John River at Clair, with its largely natural, 14 700-km² drainage basin, the maximum monthly mean value of total alkalinity was 34 mg/L as CaCO₃. During times of high streamflows, monthly mean concentrations were as low as 13.4 mg/L, with individual sample values as low as 9.5 mg/L.

Similar relationships were displayed between hardness and TDS and streamflow. (See Table 2.4.)

In north temperate areas that receive acid precipitation, the pH in streams often reaches a minimum during early snowmelt. This pH "shock" is commonly followed by peak flow and marked dilution of major ions. Laboratory and field experiments have shown that chemical impurities were preferentially lost in the first meltwater fractions (Johannessen and Henriksen, 1978, 1980; Johannes *et al.*, 1980; Siegal, 1981).

The dilution effect of spring snowmelt on Ca⁺⁺ and Mg⁺⁺ concentrations for the Saint John River at Clair is displayed in Figure 2.8. There was no strong evidence of a rise in Ca⁺⁺ or Mg⁺⁺ concentration due to "pressing out" in the early stages of melt. This may be an effect of the weekly rather than daily sampling frequency during the snowmelt period. Noticeable peak concentrations could have occurred between sampling dates.

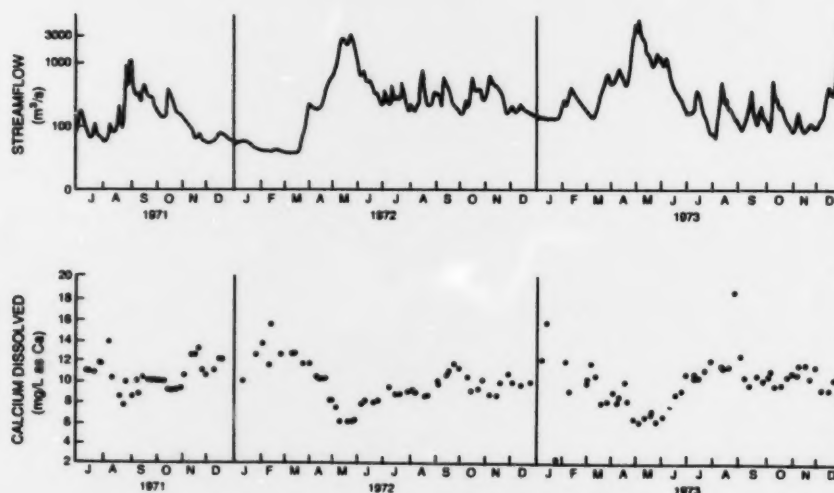


FIGURE 2.8 SELECTED WATER QUALITY DATA - SAINT JOHN RIVER AT CLAIR 1971-1973 (Figure 2.8 continued on following page.)

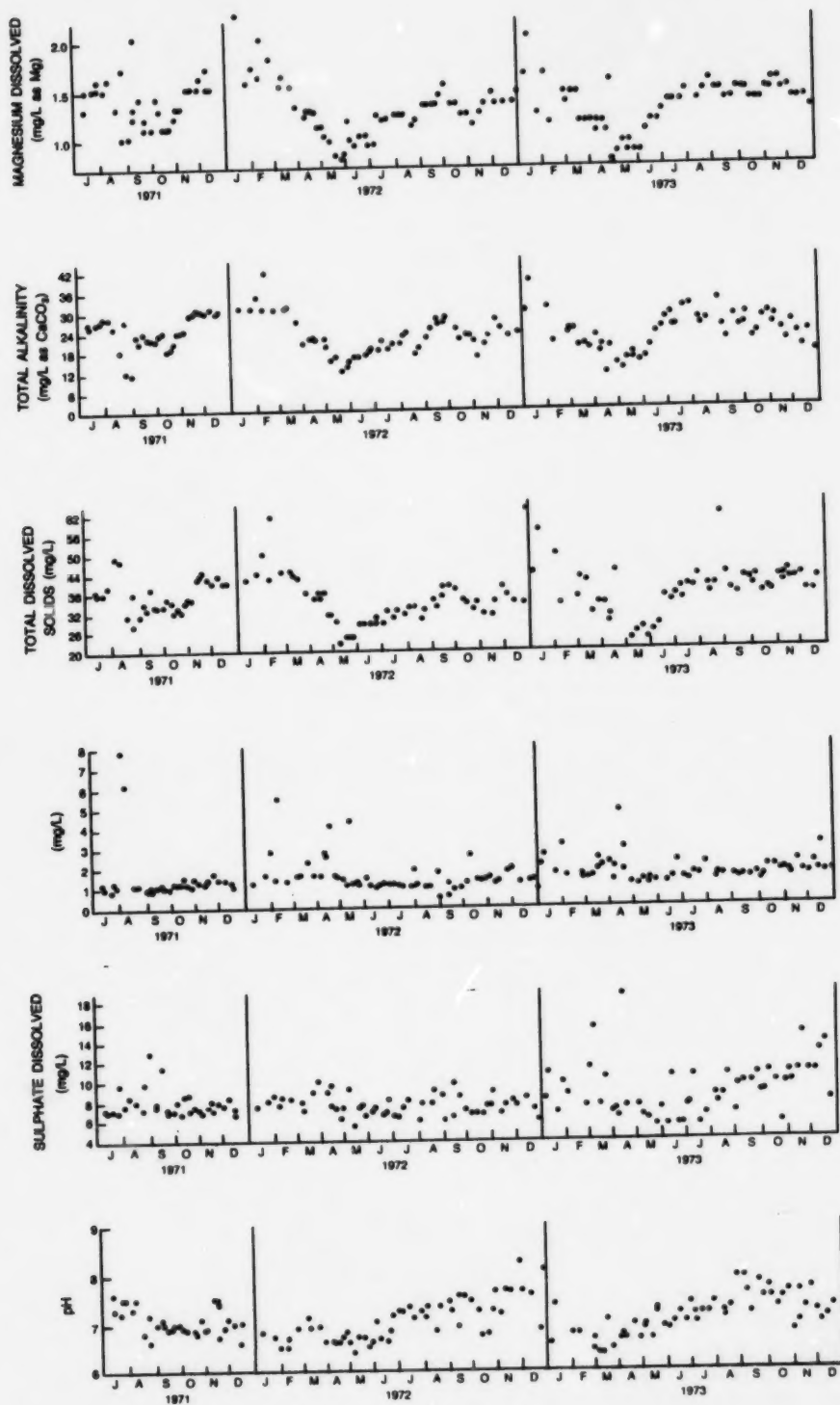


Figure 2.8 Continued.

In 1973, Cl^- and SO_4^{2-} concentrations show peaks in the early phase of snowmelt (Fig. 2.8). The peak concentrations ranged from 4 to 5 mg/L for Cl^- and 15 to 19 mg/L for SO_4^{2-} . Background concentrations were 1 to 2 mg/L and 7 to 8 mg/L, respectively.

Concentrations of the H^+ ion (represented by pH) showed a marked increase at the start of snowmelt events followed by a gradual recovery to pre-melt values. Total dissolved NO_3^- and NO_2^- concentrations decreased dramatically during the snowmelt events, with significant recovery after the end of the growing season in October.

The pH value of clean rainwater in equilibrium with atmospheric CO_2 is 5.7. The pH values of rainfall in the Atlantic region are generally below 5.0. Sulphate and nitrate concentrations appear to be increasing with time (Clair *et al.*, 1982). This is further complicated by the additional particulate accumulation or dust fallout load to the land surface. For SO_4^{2-} , the "dry" load can be assumed to be roughly 20% to 40% of the total load (Shaw, 1982).

The quality of precipitation depends on the origin and trajectory of the atmospheric moisture. Storms with the lowest precipitation pH and the highest concentrations of SO_4^{2-} and NO_3^- originate in the west and southwest (Spavold, 1979). Data from Charlo and Saint John in New Brunswick indicate variations in the pH of rainwater from 4.1 to 5.1, SO_4^{2-} from 1.2 to 7.1 mg/L, and NO_3^- from 0.1 to 1.8 mg/L (Atmospheric Environment Service, 1977). The lowest pH and highest SO_4^{2-} , NO_3^- , and cation concentrations generally occur in the first part of a storm (Spavold, 1979).

The effect of this acidic rainfall on surface water quality is a function of the capacity of the soils and bedrock to neutralize the acid. The drainage area of the Saint John River to Clair is fairly well buffered compared to much of New Brunswick. Northwest New Brunswick contains one of the least sensitive areas in the Atlantic provinces, as it is composed of Devonian shales, limestones, and Ordovician slates. Much of eastern New Brunswick is also buffered. The most sensitive part of New Brunswick is in the southwest, where a formation of Devonian granite is found. The Lepreau River watershed occupies much of that granite area and has the lowest pH values in the province (Clair *et al.*, 1982).

Streams subject to significant pH shock due to melting snow or low buffering capacity may also experience significant increases in the concentrations of toxic metals such as aluminum. No such problem was found for the Saint John River at Clair.

Areas close to the coast receive, among other constituents, substantial amounts of sea salts. This occurs when atmospheric moisture originates as saltwater or when dust particles pass through sea air and settle out over land. The average Cl^- concentration in rainfall, for example, can be several milligrams per litre near oceans and just a few tenths of a milligram per litre inland.

2.3 Coastal Atmosphere

Receiving waters located close to marine environments may contain, or even be dominated by, significant quantities of both sodium and chloride ions. Gorham (1957) and Erickson (1955) have shown that the freshwater environments with the highest levels of sodium and chloride are those located near the sea, and have suggested that the source of these ions is sea spray contained in atmospheric precipitation. Junge and Gustafson (1957) concluded the concentration of chloride decreases rapidly with increasing distances away from the sea to a constant level inland.

Examination of the data base reveals a trend for waters with a higher proportion of chloride in the eastern and western Fundy watersheds and in part of the lower Saint John watershed than is found further inland. This phenomenon is also apparent in the southern half of the eastern coastal watershed (O1BS, O1BT). However, the northern half (O1BR, O1BL) and the coastal area of the Restigouche watershed (O1BJ) experienced lower proportions of chloride than the above areas. Various other influences may be contributing to this phenomenon. For example, the high tides of the Bay of Fundy may affect water quality well up river along the Fundy coast. Another example is the Kennebecasis River, which drains areas with known salt deposits. In localized areas, base flow or runoff from the area of mines or exploration could also be contributing chloride to the river.

2.4 Classification of Water Types

2.4.1 General

All waters including streams, lakes, and ground water, contain negatively charged anions (e.g., carbonate, bicarbonate, chloride, and sulphate) and positively charged cations (e.g., potassium, sodium, calcium, and magnesium). Waters may be classified according to the proportion of these eight major ions in solution. This simple, yet fundamental, assessment of water types allows an insight into the possible origins of the water (McNeely, 1979).

2.4.2 Water Types

Fresh water, which is primarily derived from atmospheric precipitation, typically exhibits a calcium bicarbonate composition, unless unduly influenced by soil, bedrock, or exogenous input to the drainage basin.

Ground waters are strongly influenced by the composition of the surficial deposits (overburden) or bedrock with which the water comes in contact, and exhibit varying compositions accordingly. Most brackish and saline waters exhibit the typical chemical dominance of sodium chloride, with about 20 equivalent percent magnesium.

2.4.3 Ionic Proportion Diagrams

One method to illustrate the major ion chemistry of water graphically is to use ionic proportion diagrams. These diagrams allow a visual appreciation of both the water type and the relative proportion of each ion (Fig. 2.9).

The relative proportion (as equivalent percent) of each of the major ions is plotted on a "rosette" diagram. A circle is divided into two equal fields representing 100% of either anions or cations. Both fields are further subdivided into four sectors representing the individual major ions. The concentrations in milliequivalents per litre of the individual major ions are then converted to percents of either the anionic or cationic field. The length of the bisecting radius in each of the sectors is proportional to the equivalent concentration of that ion, and thus the enclosed polygon (shaded area in Fig. 2.9) is directly proportional to the equivalent percent of that ion. The circumference of the circle represents 25 equivalent percent. Therefore, values less than 25% lie within the circle, whereas values greater than 25% extend beyond the circle. The magnitude of the total dissolved solids at a site can be indicated by colour coding the rosette.

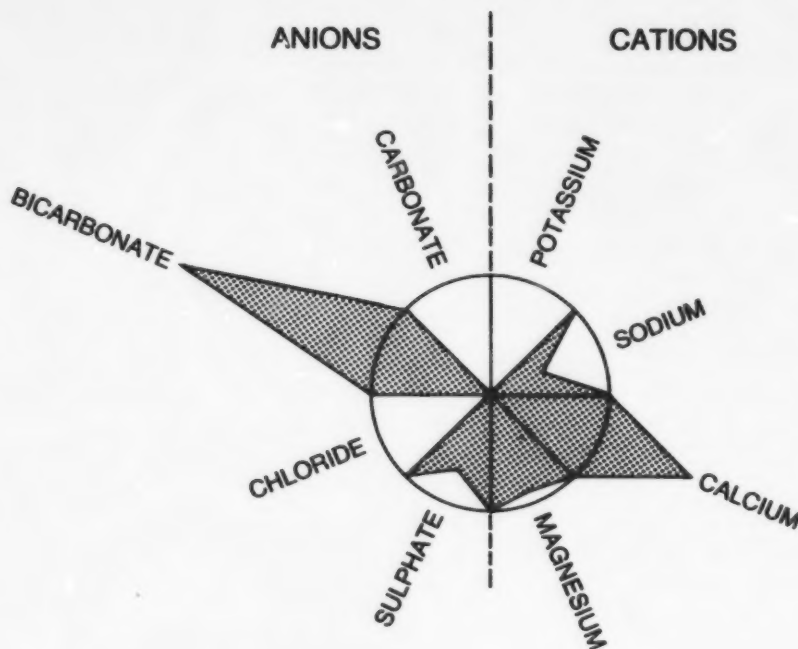


FIGURE 2.9 IONIC PROPORTION DIAGRAM

2.4.4 Piper Trilinear Diagrams

Figure 2.10 shows a Piper trilinear diagram (Hem, 1965). The three axes represent the concentrations of (i) cations (calcium, magnesium, and alkali metals), (ii) anions (chloride, sulphate, and carbonate and bicarbonate), and (iii) ionic-groups (alkali metals, alkaline-earth metals, carbonate and bicarbonate, and chloride and sulphate) in natural waters. On the upper diamond-shaped portion of the diagram, freshwater plots to the left, whereas saline water plots to the right. Natural unaltered waters will tend to plot in the lower left corner of the anion triangle. As surface waters receive increasing inputs from urban/industrial activities, thus increasing sulphate and chloride concentrations, the ion proportions will tend to move along the arrow "A." If a sensitive system is subjected to predominantly sulphate inputs of atmospheric or geochemical origin (e.g., "acid rain" or acid-mine drainage), the ion proportions will change as indicated by arrow "B" (McNeely, 1979).

2.4.5 Basin Water Types

2.4.5.1 Miramichi River Basin

(a) Surface Water

All 14 surface-water sites in the Miramichi River basin with sufficient major ion data to assess had calcium bicarbonate waters of very low dissolved solute content. All sites had total dissolved solids concentrations of less than 60 mg/L and some were even less than 25 mg/L. The median value was 30 mg/L (Fig. 2.11). All sites exhibited significant

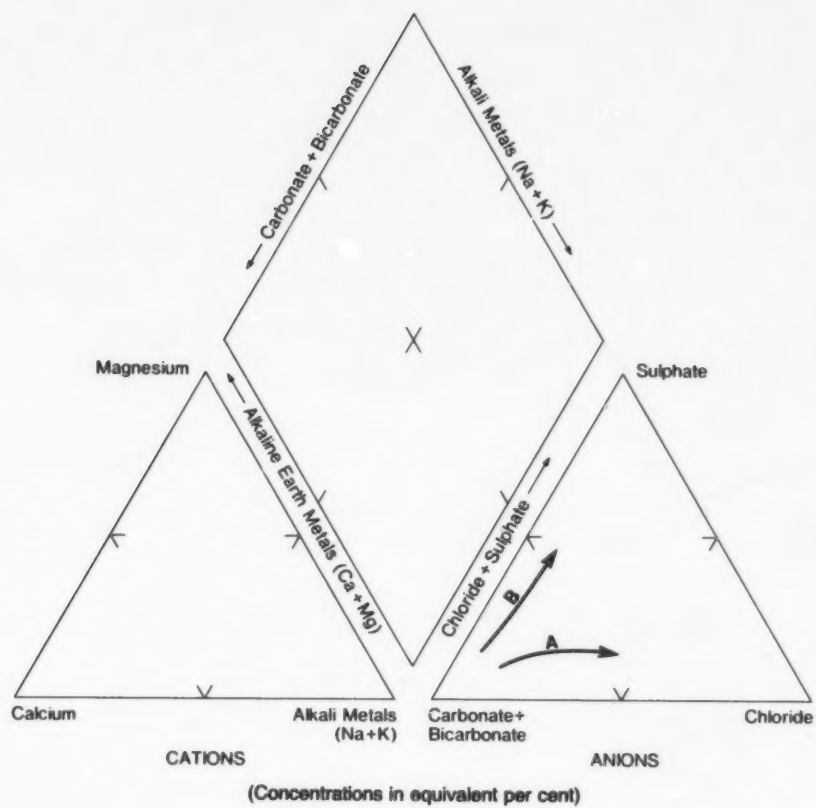


FIGURE 2.10 PIPER TRILINEAR DIAGRAM

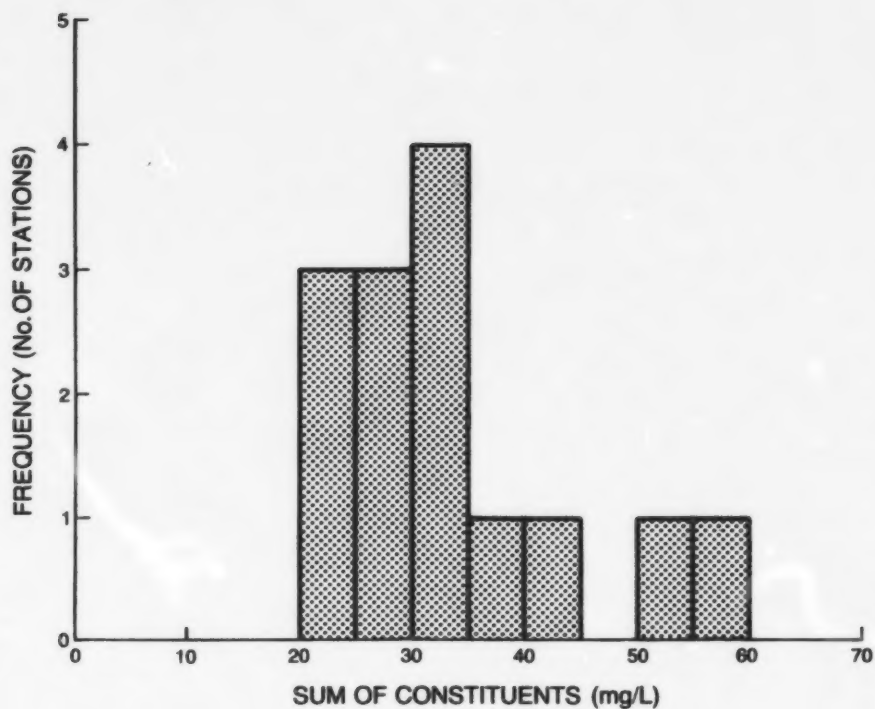


FIGURE 2.11 MIRAMICHI RIVER BASIN - SURFACE WATER -
TOTAL DISSOLVED SOLIDS

sulphate levels; only four sites had less than 25 equivalent percent sulphate; and one site (station OONB01BQ0044) exhibited a sulphate level in excess of 60 equivalent percent sulphate. This high sulphate value is strongly suggestive of acid-mine drainage.

On the trilinear plot (Fig. 2.12) the 14 sites tend to aggregate into two groups: five with slight sulphate content and eight with moderate sulphate influence, plus one with very strong sulphate influence. Station OONB01BQ0044, as well as many of the other stations with elevated sulphate levels, appear on the mainstream of the Northwest Miramichi, which drains the area of most active mining activities in the basin.

(b) Ground Water

Since ground water is influenced by the aquifer that it resides in or passes through, the Miramichi ground-water stations exhibited a much broader range of water types than did the surface waters, varying from calcium bicarbonate to sodium chloride waters. Typically the dissolved solutes in the ground waters (Fig. 2.13) were much higher than in the surface waters; only two ground-water sites had median TDS concentrations of less than 100 mg/L. All TDS concentrations were greater than the surface-water concentrations. The median ground-water TDS concentration in the basin was in excess of 200 mg/L, with an extreme value of 1030 mg/L observed in the Ellis Street Well, Chatham, New Brunswick.

The anion triangle (Fig. 2.14) indicates that there were at least two types of ground water in the basin, namely fresh and brackish waters. The diamond portion of the plot, however, suggested that there may even be three groups: fresh water (14 stations), brackish water (10 stations), and saline water (14 stations). The fresh waters were basically calcium bicarbonate, with varying proportions of sodium sulphate, whereas the brackish group of waters exhibited elevated chloride concentrations. The saline waters, on the other hand, were rich in sodium chloride. It is interesting to note that three of the four saline ground waters occur in areas remote from the coast.

2.4.5.2 Restigouche River Basin

For the purpose of classifying the water types, the Restigouche River basin was subdivided into the Nepisiguit River and the Restigouche River watersheds.

2.4.5.2.1 Nepisiguit River Watershed

(a) Surface Water

There were only five stations within the Nepisiguit River watershed with sufficient major ion chemistry data to allow the assessment of water type. The dissolved solids content (Fig. 2.15) at these stations was very low and ranged from 25 to 50 mg/L, with a median of 31 mg/L. The dominant major ions (Fig. 2.16) were calcium and bicarbonate, with 15 to 20 equivalent percent of sodium and magnesium and varying amounts of sulphate. Two sites (stations OONB01BK0015 and OONB01BK0026) exhibited sulphate levels equivalent to bicarbonate, which suggests that these sites were influenced by acid-mine drainage. Thus the basic water type in this watershed was calcium bicarbonate. At two sites this was modified to a calcium bicarbonate-sulphate water.

(b) Ground Water

There were insufficient data for an analysis of water types in the Nepisiguit River watershed.

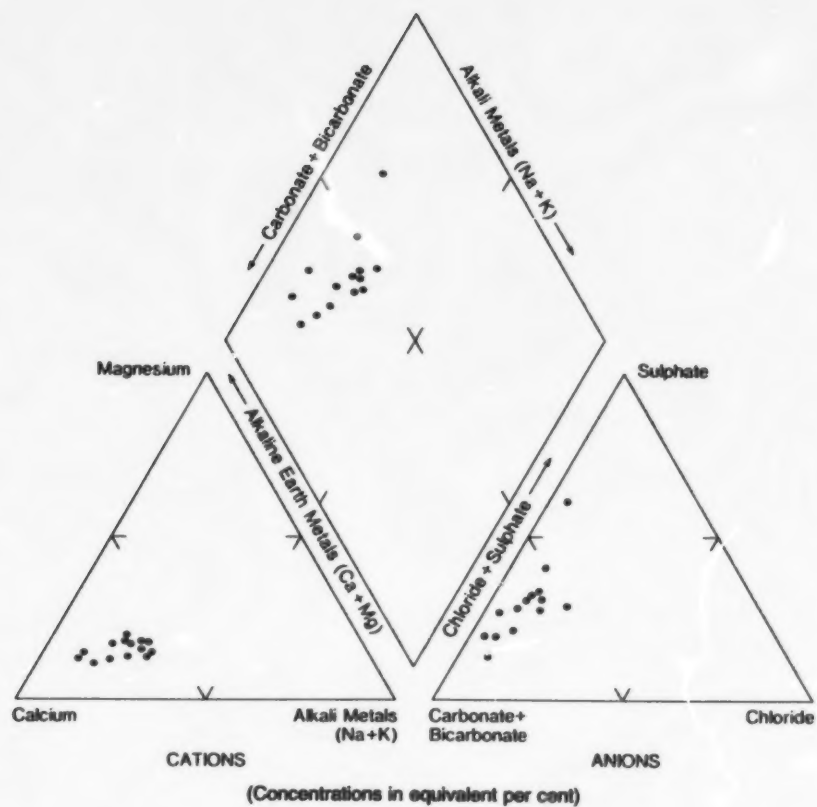


FIGURE 2.12 MIRAMICHI RIVER BASIN – MAJOR ION CHEMISTRY – SURFACE WATER

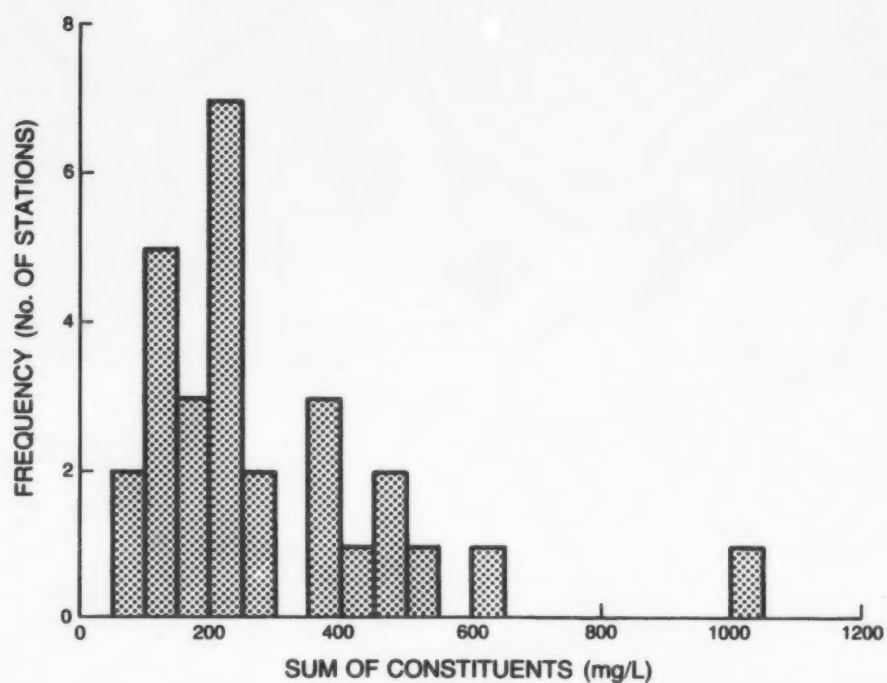


FIGURE 2.13 MIRAMICHI RIVER BASIN - GROUND WATER -
TOTAL DISSOLVED SOLIDS

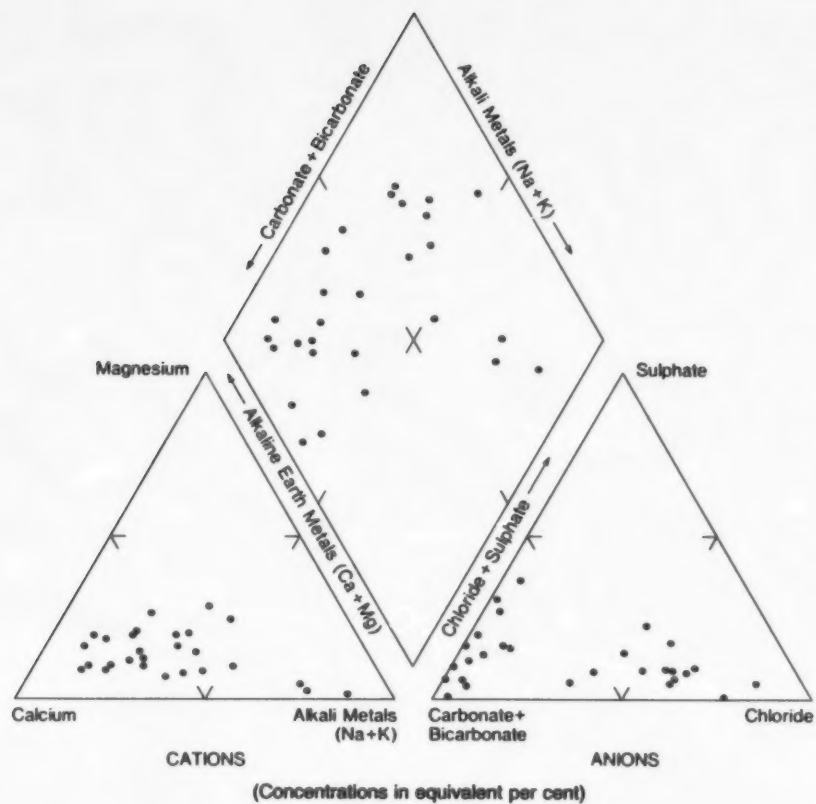


FIGURE 2.14 MIRAMICHI RIVER BASIN – MAJOR ION CHEMISTRY – GROUND WATER

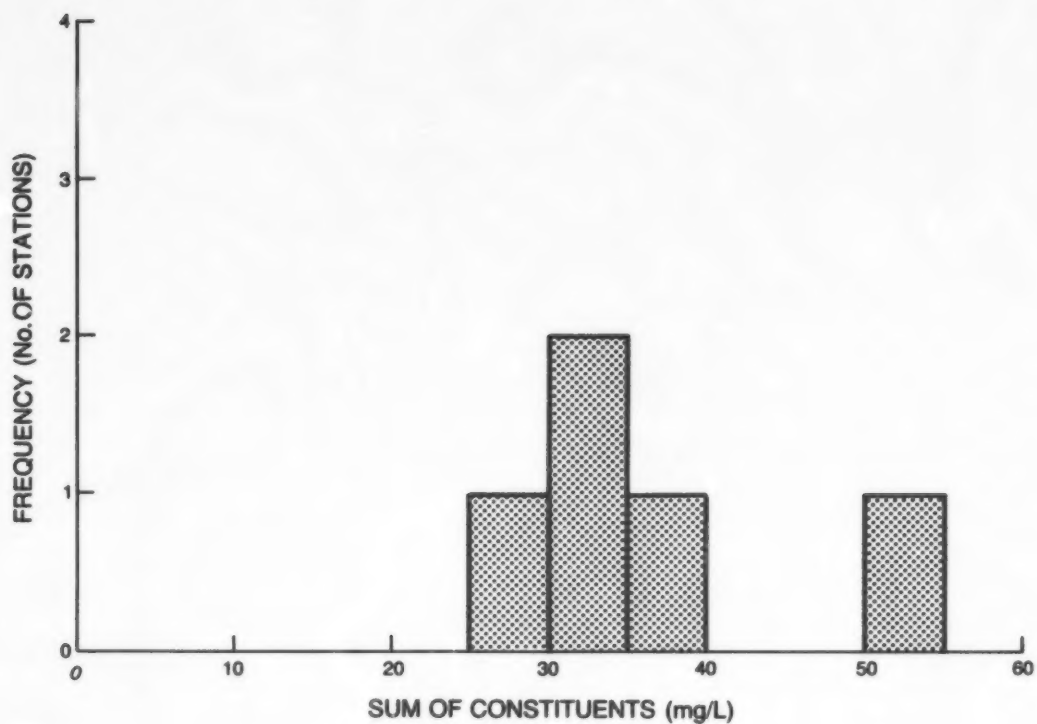


FIGURE 2.15 NEPISIGUIT RIVER BASIN - SURFACE WATER - TOTAL DISSOLVED SOLIDS

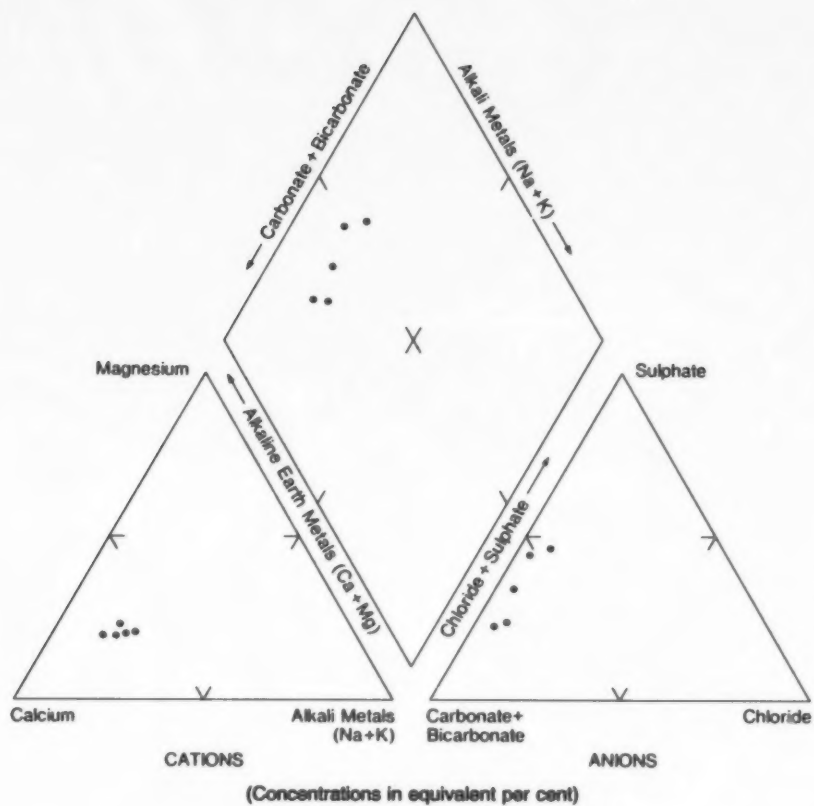


FIGURE 2.16 NEPISQUIT RIVER BASIN – MAJOR ION CHEMISTRY – SURFACE WATER

2.4.5.2.2 Restigouche River Watershed

(a) Surface Water

Seven of the eight surface-water stations, including the Restigouche River, exhibited strong calcium bicarbonate water of low dissolved solids content (TDS ranged from 60 to 150 mg/L). Only one site, Upsalquitch Lake (01NB01BE0001), located in a mining area with a low median TDS concentration (25 mg/L), showed elevated sulphate levels.

(b) Ground Water

More than half of the ground-water sites in the Restigouche River watershed were calcium bicarbonate waters. Dissolved solids concentrations were similar to the surface waters, although one site, the Charlo town supply, had a median TDS concentration greater than 275 mg/L. Two wells in the Nigadoo area indicated a possible marine influence or saltwater intrusion into the aquifer.

2.4.5.3 Upper Saint John River Basin

(a) Surface Water

All 20 surface-water stations in the upper Saint John River basin were strongly calcium bicarbonate with varying, slight to moderate, proportions of sulphate (Fig. 2.17). Only two stations, one on the Limestone River and the other on Black Brook, had dissolved solids concentrations in excess of 135 mg/L.

(b) Ground Water

The ground-water stations in the upper Saint John River basin were somewhat more variable in their chemical composition, yet they were basically calcium bicarbonate waters, with varying proportions of chloride. One well in the St. Basile area (10BR01AF0018) was a mixed water type: calcium bicarbonate strongly influenced by sodium chloride. All the ground waters had TDS concentrations higher than most of the surface waters.

2.4.5.4 Middle Saint John River Basin

(a) Surface Water

The majority of the surface waters in the middle Saint John River basin were calcium bicarbonate waters with variable levels of sulphate, usually less than 30 equivalent percent. Only the Nashwaak and Nashwaaksis river sub-basins exhibited mixed water types of calcium bicarbonate/sodium chloride-sulphate, which probably relates to the underlying sedimentary rocks in the sub-basins. The TDS levels ranged from 19.5 to 247.4 mg/L, with a median value of 74 mg/L.

(b) Ground Water

Eighty-five percent of the ground-water stations sampled were predominantly bicarbonate waters (Fig. 2.18). Two sites had elevated magnesium levels, presumably related to dolomite bedrock in the Silverwood area. Six sites exhibited elevated sodium chloride levels and were either sodium chloride waters or mixed (sodium chloride/calcium bicarbonate-sulphate) waters. The TDS ranged from 59 to 807 mg/L, with a median value of 201 mg/L.

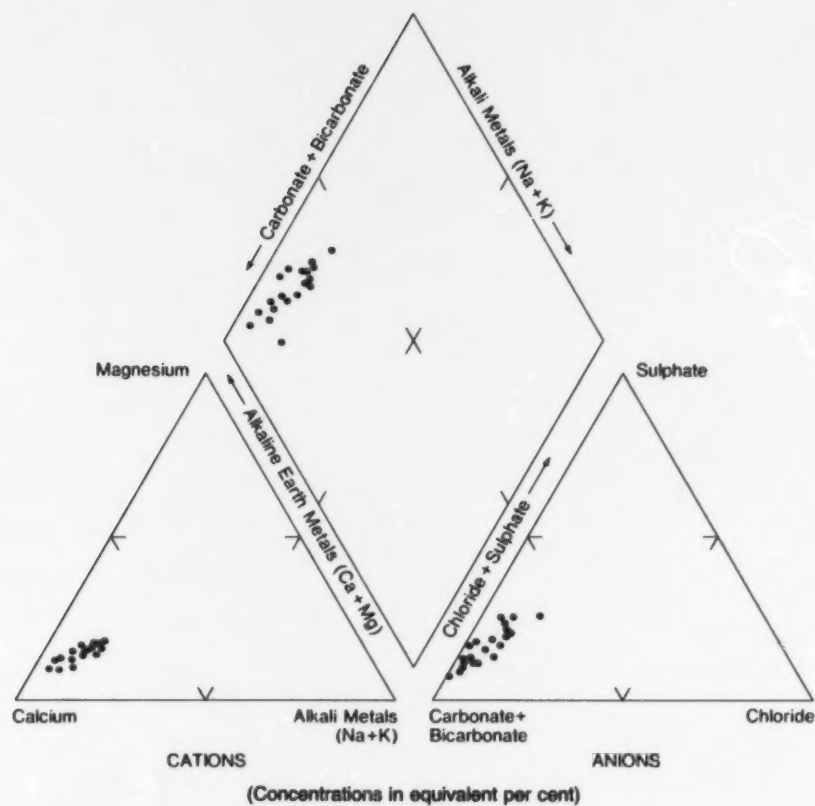


FIGURE 2.17 UPPER SAINT JOHN RIVER BASIN – MAJOR ION CHEMISTRY – SURFACE WATER

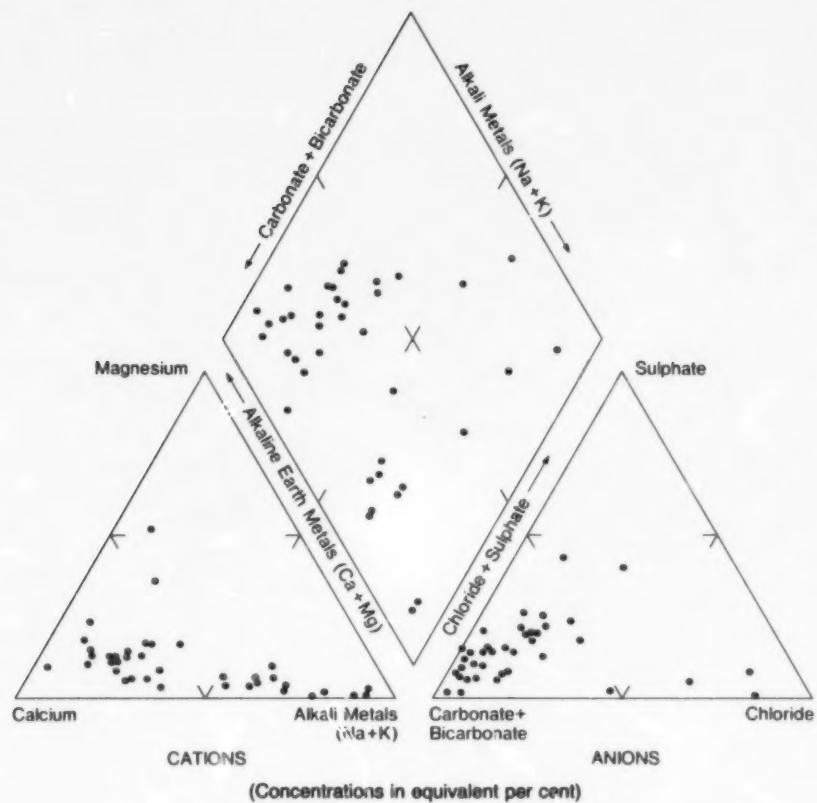


FIGURE 2.18 MIDDLE SAINT JOHN RIVER BASIN – MAJOR ION CHEMISTRY – GROUND WATER

2.4.5.5 Lower Saint John River Basin

(a) Surface Water

Although the water types in the lower Saint John River basin were quite variable (Fig. 2.19), their dissolved solids concentrations remained low to moderate ranging from 17 to 115 mg/L. The exception was station 00BN01AP0012, where a TDS in excess of 18 000 mg/L was recorded. This station was located in the Saint John Harbour and is characteristic of saline water. Fewer than one third of the stations were dominated by calcium bicarbonate: the Saint John River, the headwaters of the Kennebecasis River, the Little River (east of Saint John), and the Nerepsis River. The latter two stations indicated a slight influence of sodium chloride, possibly related to their nearness to the Fundy Coast. A strong marine (sodium chloride) influence was evident in Spruce Lake (01NB01AP0008) located near the Fundy Coast.

Four sites in the coal mining area around Minto—the Little, Newcastle, Salmon, and Jemseg rivers—exhibited elevated sulphate levels typical of acid-mine drainage. Two stations on the middle (Apoahqui) and lower (Hampton) Kennebecasis River showed moderate proportions of sodium chloride, whereas the Kennebecasis station (00NB01AP0032) was strongly influenced by the salt deposits in the region. This site also had an elevated TDS concentration (110 mg/L) compared to the other sites in the basin. The six remaining sites on the Canaan, Otnabog, Oromocto, and Upper Salmon rivers were mixed water types, composed of calcium carbonate with varying levels of sodium, chloride, and sulphate.

(b) Ground Water

The ground waters in the lower Saint John River basin were quite variable in water type. Dissolved solids concentrations ranged from 104 to 2330 mg/L, with a median value of 333 mg/L. Two sites in the Minto area exhibited extreme proportions of sulphate related to the oxidation of sulphides in the coal deposits. Another two sites in the Hampton area had excessive chloride concentrations, with the major cation being calcium rather than sodium.

Station 10BR01AP0118 exhibited a distinct mixed calcium bicarbonate-sodium chloride water type. Sodium chloride was dominant in three wells in the west central part of the basin at Tracy, Geary, and Upper Maugerville. The site at Nasonworth was a mixed water type of sodium chloride, bicarbonate, and sulphate similar to the four sites in the upper reaches of the Salmon River. Nine sites in the basin exhibited a predominant calcium bicarbonate type of water especially in the Kennebecasis and Canaan river basins, and in the vicinity of Little Lake and Oromocto. An additional 15 stations throughout the basin exhibited a sodium bicarbonate water type.

2.4.5.6 Western Coastal Basin

The western coastal basin consisted of all the waters in sub-basins 01AQ and 01AR (Fig. 1.8). These waters all flow into the Bay of Fundy west of the Saint John River.

(a) Surface Water

The surface waters in this basin were very dilute, with a TDS ranging from 12 to 35 mg/L (Fig. 2.20), and were influenced by the marine environment. Sixty percent of the sites sampled were mixed calcium bicarbonate/sodium chloride-sulphate types (Fig. 2.21). The sites exhibiting the highest sodium chloride proportions were nearest the coast. Inland, the waters had a calcium bicarbonate-sulphate composition with less sodium chloride in evidence.

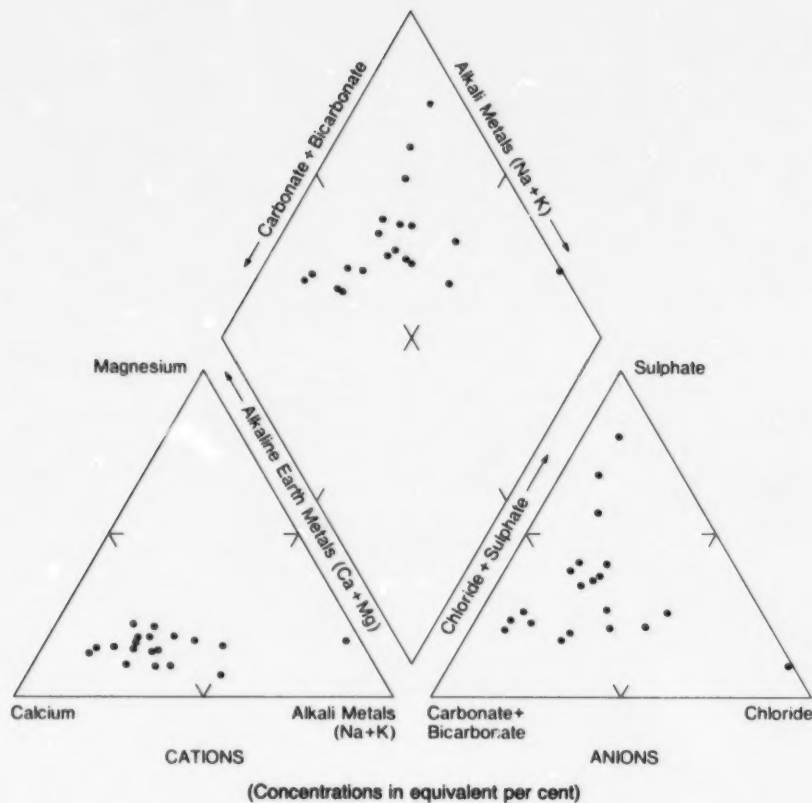


FIGURE 2.19 LOWER SAINT JOHN RIVER BASIN – MAJOR ION CHEMISTRY – SURFACE WATER

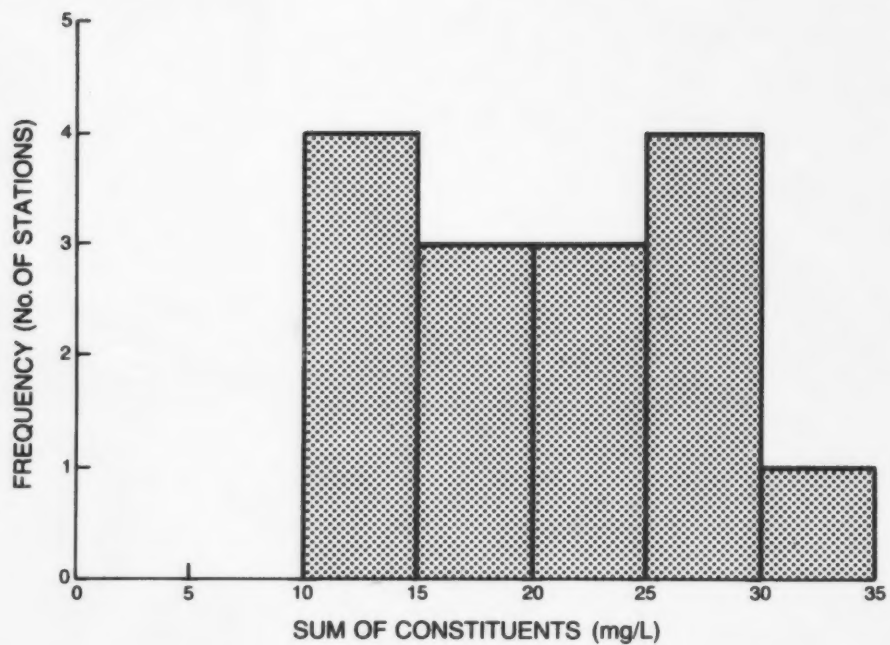


FIGURE 2.20 WESTERN COASTAL BASIN - SURFACE WATER -
TOTAL DISSOLVED SOLIDS

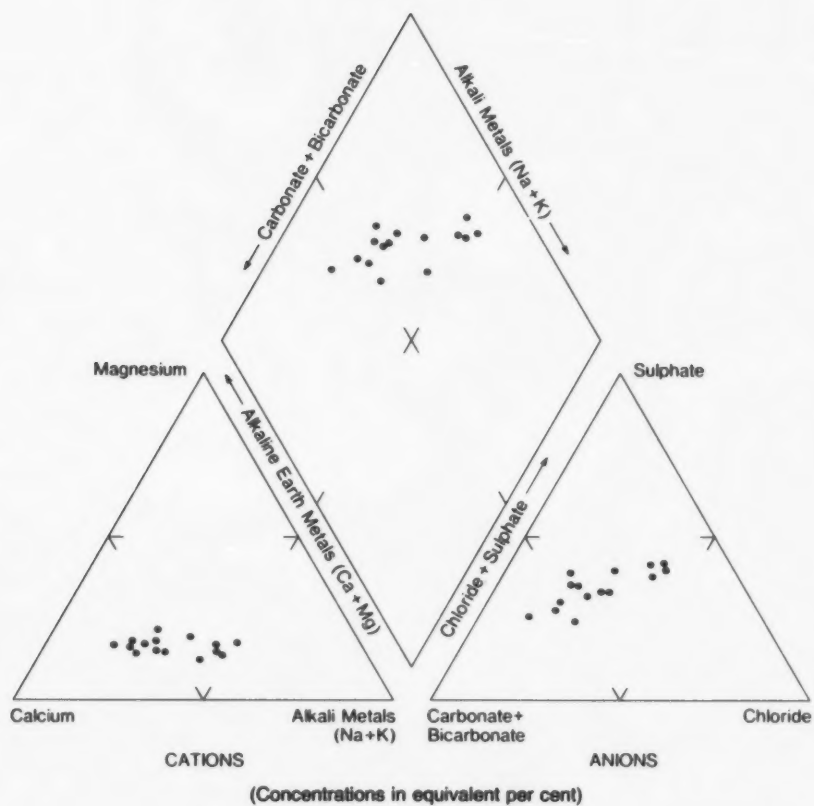


FIGURE 2.21 WESTERN COASTAL BASIN - MAJOR ION CHEMISTRY - SURFACE WATER

(b) Ground Water

There were only two ground-water sites in this basin, and both were calcium carbonate waters with some sodium chloride (25%). Since the St. Stephen well was in an alluvian deposit, its total dissolved solids content was low, yet slightly higher than the average surface waters in the area.

2.4.5.7 Eastern Coastal Basin

(a) Surface Water

All of the surface waters analyzed from the east Fundy coast (sub-basins 01BV and 01BU) had mixed chemical compositions. All the sites had less than 20% sodium; five sites had greater than 50% bicarbonate; and some sites had 40% to 50% chloride or sulphate or a combination of both. The dissolved solutes of all samples, except for station 00NB01BU0031 (Petitcodiac River at Highway 2), were very low, ranging from 13 to 74 mg/L. The mixed composition of the waters probably resulted from their low solute content being influenced by marine spray in the coastal areas and from the presence of evaporitic deposits at the inland sites (Petitcodiac River basin). The samples high in sulphate were quite different from the other areas in the province (low TDS, mixed compositions of calcium bicarbonate/sodium chloride-sulphate).

Most of the Gulf of St. Lawrence coastal rivers (sub-basins 01BL, 01BR, 01BS, and 01BT) and the Caraquet, Tracadie, Tabusintac, Kouchibouguac, and Richibucto rivers were dilute calcium bicarbonate waters changing to brackish water (sodium chloride) in their lower reaches (e.g., station 00NB01BL0032). Some of the rivers (the Coal Branch, Buctouche and Cocagne rivers) exhibited mixed water types--calcium bicarbonate/sodium chloride-sulphate. This was a result of underlying sedimentary bedrock. These rivers, however, were still quite low in total dissolved solids.

(b) Ground Water

The ground-water data of the eastern Fundy coastal area indicated higher concentrations of solutes than the surface waters of that area. The calcium bicarbonate (Fig. 2.22) waters ranged from 151 to 211 mg/L TDS. The sodium bicarbonate and mixed composition waters ranged up to 436 mg/L TDS. The sodium chloride waters were high to brackish in TDS (e.g., site 10BR01BU0059 at 11 900 mg/L). The unusual composition (sodium sulphate bicarbonate) of the Memramcook post office well, with its extremely high TDS (1141 mg/L), may be related to a water softener.

Waters from the 39 ground-water stations located on the gulf side of this basin (sub-basins 01BL, 01BR, 01BS, and 01BT) were analyzed (Figs. 2.23 and 2.24). The dissolved solids concentrations in these ground waters were higher than the surface-water samples from the same area. The TDS ranged from 93 to 684 mg/L with a median value of 271 mg/L. Five sites were strongly influenced by saltwater intrusions and exhibited a sodium chloride composition with dissolved solids in excess of 600 mg/L.

Several sites had a typical calcium-magnesium bicarbonate water type. This was probably a result of the dolomite bedrock. One station at Aulac exhibited a calcium-magnesium sulphate composition and was related to the gypsum deposits in the area. Seven other sites had mixed calcium bicarbonate/sodium chloride-sulphate compositions, and ten sites were probably affected by water softeners and had sodium sulphate compositions.

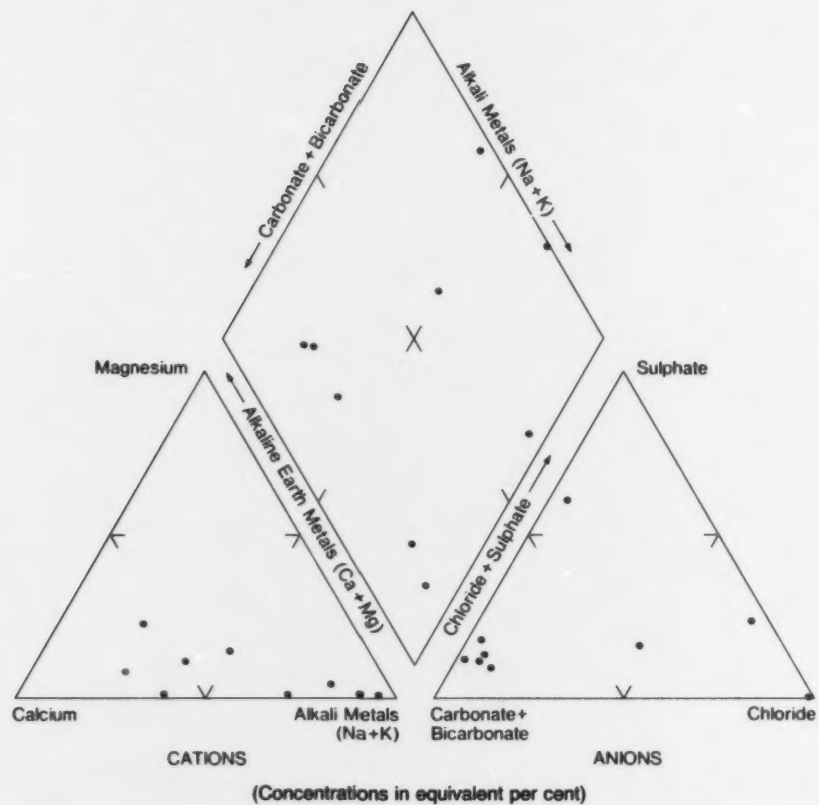


FIGURE 2.22 EASTERN COASTAL (EAST FUNDY) BASIN - MAJOR ION CHEMISTRY - GROUND WATER

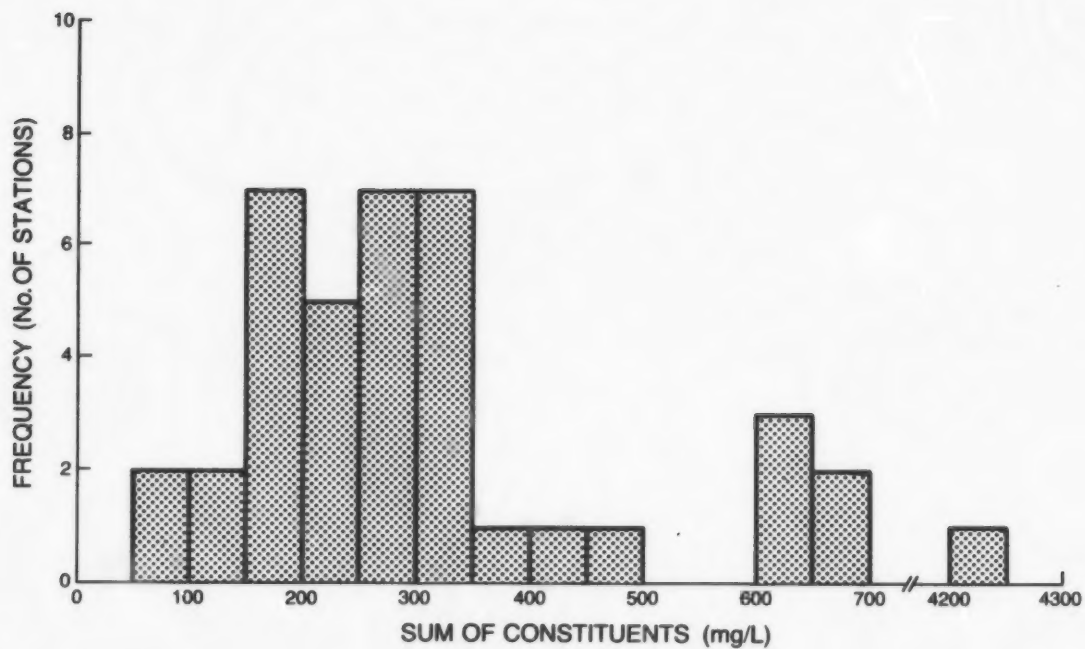


FIGURE 2.23 EASTERN COASTAL (GULF) BASIN - GROUND WATER -
TOTAL DISSOLVED SOLIDS

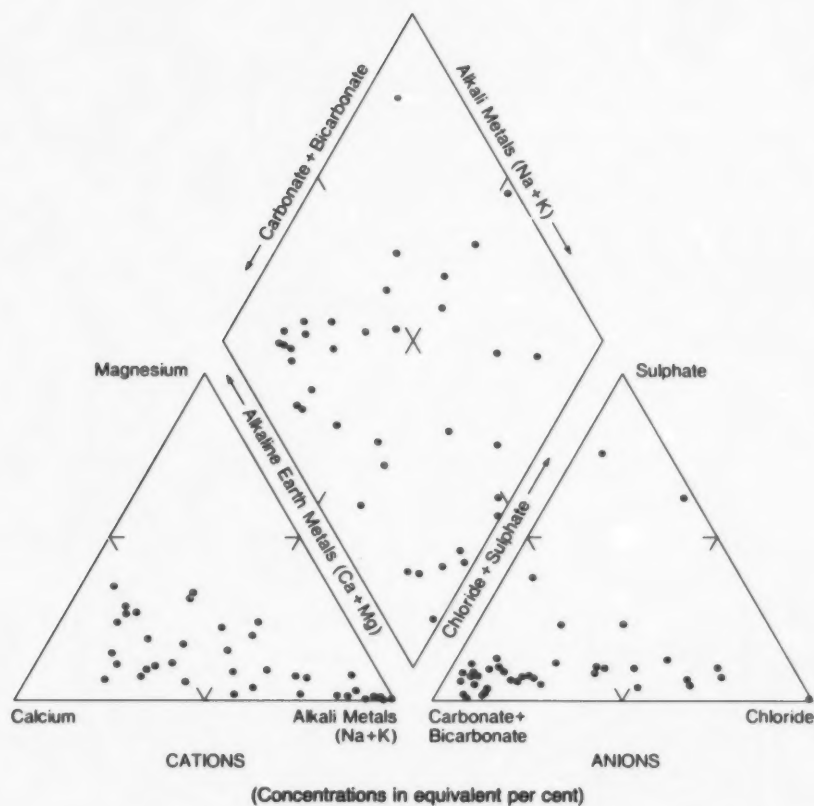


FIGURE 2.24 EASTERN COASTAL (GULF) BASIN - MAJOR ION CHEMISTRY - GROUND WATER

CHAPTER THREE

ANTHROPOGENIC INFLUENCES ON WATER QUALITY

In addition to the natural influences on water quality discussed in the previous chapter, human activities have a significant impact on water resources. By understanding the nature and magnitude of these anthropogenic impacts, managers have a better insight into the problems they face. One way of classifying anthropogenic influences is into point and non-point sources. Point source water quality information can be collected from controlled outflows. The non-point sources are, by their very nature, diffuse, and therefore difficult to identify and quantify.

Forestry and agriculture are addressed under the "non-point source" heading. Food processing, mining, and pulp and paper are addressed under the "point source" heading. These five anthropogenic influences cover most of the major human activities currently operating within New Brunswick, with the exception of urban runoff.

3.1 Non-point Sources

Diffuse sources of pollution loads originating from forestry and agriculture practices contribute to water quality degradation in certain New Brunswick watersheds. The resulting influences having an impact on the aquatic environment include erosion and sedimentation, increased overland flow, leaching of nutrients or fertilizers and pesticides, excessive heating of the water, and animal waste and silage making. Non-point sources derived from anthropogenic practices are difficult to discern and control over extensive drainage areas. These sources are major concerns for the water resources manager.

3.1.1 Agriculture

3.1.1.1 General

The management of contaminants (e.g., nutrients, pesticides, and sediments from erosion) from agricultural runoff in New Brunswick is a problem and will be further aggravated as agriculture becomes increasingly industrialized, i.e., relies more and more on the use of chemicals.

There are a number of water quality impacts associated with agricultural activities: fertilizers and pesticides, animal waste and silage making, soil erosion and sedimentation.

Both surface waters and ground waters are susceptible to contamination by agricultural activities through infiltration, runoff, erosion, adsorption-desorption, and chemical transformation. The magnitude of the impact also varies with crop, soil, weather, and management practices (Baker, 1980). One known fact is that the amount and types of pollutants contained in the runoff and infiltration from agricultural areas vary significantly. The greater the extent of human utilization or animal density, the greater the impact on water quality.

3.1.1.2 Impact of Pollutants

3.1.1.2.1 Fertilizers and Pesticides

Chemical fertilizers and pesticides are considered essential in meeting today's current food and fiber needs (Maine Department of Environmental Protection, 1979). The rapid expansion of fertilizer use since the early 1940s, while permitting enhanced crop production, has also led to increased concerns over nutrient pollution of surface and ground

water (MONENCO, 1973). Application of fertilizers has caused nutrient buildup, with subsequent accelerated eutrophication, in adjacent receiving waters. The latter can impair downstream water resources for recreation, water supply, and use as natural fisheries potential.

The nutrients that are of most concern are nitrogen and phosphorous. It has been demonstrated that the combined effects of fertilization and agricultural drainage produced 4 to 5 times more phosphorus and 40 to 50 times more nitrate from cultivated as compared to uncultivated watersheds. In addition, the mean concentration of inorganic nitrogen in ground water within cultivated watersheds was approximately 10 times higher than levels measured in uncultivated plots during the same growing season.

In New Brunswick, approximately 80% of the fertilizer application is in the Saint John River basin, with the heaviest concentrations in Madawaska, Victoria, Carleton, and King's counties (MONENCO, 1973). This reflects the concentration of potato and grain production in the first three counties and grain and foliage in the last county.

The most important consequence of the use of pesticides is their persistence in the environment. The primary sources of pesticide contamination to receiving waters are pesticides adhering to soil particles eroded from treated agricultural lands and pesticides dissolved in runoff water (MONENCO, 1973). Other sources include overspraying, drift, and negligent disposal of containers. In the past, agricultural pesticide-related fish kills in the Maritimes were usually caused by improper filling of spray equipment from streams and discharge of contaminated rinse water to streams (Wilson *et al.*, 1980). Farmer education has all but eliminated these problems.

In New Brunswick, agricultural pesticides were applied mainly to potatoes, grain, apples, fodder, corn, strawberries, and vegetables. The application to potatoes represented over 95% of the total usage (MONENCO, 1973). Wilson *et al.* (1980) have reported that very little information was available on effects of agricultural pesticides in the Atlantic region, except that the amounts reaching surface waters were usually so low that they could seldom be detected in routine analyses of water.

3.1.1.2.2 Animal Waste and Silage Making

Another non-point source from agricultural lands is waste from animal husbandry. The major water quality impact is caused by manure that is either improperly stored or poorly spread or that results from the direct entry of animals into the waterways. This contamination is essentially organic matter in suspension, together with proteinaceous and carbohydrate residuals in colloidal solution, containing high concentrations of ammonia, potassium, chloride, phosphate, and pathogenic microorganisms. Silage effluent, on the other hand, is mostly organic and mineral matter in solution, which also includes proteins, carbohydrates, ammonia, and mineral salts (Fish, 1973).

Very little has been reported about this type of non-point source pollution in the Atlantic region. Waller (1978) discussed the generation and application of manure in the Shubenacadie-Stewiacke River basin. Based on work conducted in the U.S.A., Waller reported the annual production of manure by animal species as shown in Table 3.1. From this it can be concluded that animal wastes constitute one of the significant sources of bacteria in water, second only to municipal discharge.

3.1.1.2.3 Soil Erosion and Sedimentation

Erosion is the transport of soil overland due to surface runoff. Sedimentation, on the other hand, is soil transport by moving water such as streams and rivers. These two

Table 3.1. Annual Manure Production (kg/animal)

	BOD	N	P	Fecal coliform (No./a)
Cow	331	38	25	197×10^{10}
Hog	53	23	8	325×10^{10}
Sheep	41	11	2	657×10^{10}
Chicken	2.5	0.5	0.2	8.76×10^{10}

processes vary according to climate, topography, riverbed slope, and the characteristics of the land through which or over which the water flows. This transport of soil eventually leads to a deposition of material on streambeds, in headponds, in estuaries, and at sea. Agricultural land is only one of many sources of soils that eventually enter water bodies (MONENCO, 1973).

Sediment is a complex mixture with numerous physical, chemical, and biological implications. It is recognized as a pollutant when it fills reservoirs, lakes, and ponds; clogs stream channels; impairs water-distribution systems; destroys aquatic habitats; and degrades other beneficial uses such as domestic consumption and recreation. Sediment is also a carrier of other pollutants such as nutrients, pesticides, toxic metals, and even bacteria and viruses (Purdue University, 1972). A less direct impact results from the fact that soil loss leads to decreased crop productivity, which is usually followed by an increased use of fertilizers and pesticides.

Sediment loading to the aquatic environment is a concern to water resource managers. There are no satisfactory procedures for predicting sediment yields downstream from where erosion occurs, apart from various preliminary mathematical models. Monitoring of streams yields information on the quantity of sediment present in water, but not on where it originated or how much is likely to be deposited (MONENCO, 1973). In New Brunswick, sediment concentrations typically range from 10 to 1000 mg/L (Environment Canada, 1988).

When compared to forestry operations, agricultural practices have a greater potential for aquatic environmental damage through soil erosion and stream siltation. In New Brunswick, the actual extent of damage from farmland erosion is less significant because of the relatively low proportion of land used for agricultural purposes. It has been calculated that only 37-74 t/ha of topsoil were eroded from farms each year (Wilson *et al.*, 1980).

3.1.1.3 Agricultural Lands

In New Brunswick, Victoria and Carleton counties have the heaviest concentration in cropland. Victoria County's agricultural centre is the St. André-Grand Falls-New Denmark-Limestone area. Carleton County's centre is the Bristol-Florenceville-Hartland-Woodstock area. Agricultural impacts would therefore be predicted for the Saint John River between St. Leonard and Morrell including the Little and Salmon river tributaries and between Bath and Northampton including the Shikatehawk, Big Presquille, Becaguinec, and Meduxnekeag river tributaries.

Pasturelands in New Brunswick are scattered throughout the southwestern portions of the province. The heaviest concentrations are in King's and Westmorland counties with lesser amounts in Kent County. In King's County, the predominant pastureland area is the Penobscis-Sussex-Worton-Hampton stretch with probable impact on the Kennebecasis River

and its tributaries, the Studholm and South Branch rivers. In Westmorland County, pasturelands are concentrated in the Petitcodiac-Salisbury area, where the major surface-water bodies are the Petitcodiac and North rivers and in the Memramcook River basin.

Although much less extensive, Kent County has some large "community pastures" in the headwaters of the Buctouche and Richibucto rivers where some animal husbandry impacts could be expected. Aside from the above, the upper Saint John River from Connors to Edmundston (sub-basin O1AD) could also be expected to be influenced by the high intensity of the poultry- and pig-raising industry in the area.

3.1.1.4 Observed Agricultural Influences

To evaluate the impact of the agricultural sector on surface water in New Brunswick, the sub-basins that would most likely be influenced by this activity were identified. As previously stated, high intensity farming is located in sub-basins O1AF, O1AG, and O1AJ, and pasturelands are concentrated in sub-basins O1AP, O1BU, and O1BS (Fig. 1.2). Poultry and pig raising are carried out predominantly in sub-basin O1AD.

A review of the data by sub-basin in the high-intensity farming area showed that nitrate and nitrite values were above average in sub-basins O1AF and O1AG and that sub-basins O1AF, O1AG, and O1AJ were high in total phosphate. Moreover, values for total dissolved solids were found to be above the provincial average in sub-basin O1AF. All of these findings are consistent with the predicted impact of farmland on surface waters.

In the pasturelands, total and fecal coliform values were found to be well above average in sub-basin O1AP, and ammonia was found to be high in sub-basin O1AD, consistent with the described impact of animal husbandry. Data for these parameters in sub-basins O1BU and O1BS were sparse and could not be confidently interpreted.

In summary, many of the expected agricultural influences on surface waters are readily discernible in areas where this activity is highly concentrated. The predicted impacts that were not observed in some sub-basins can be explained by either insufficient data or a masking of the impact by some other land use activity.

3.1.2 Forestry

3.1.2.1 General

Undisturbed forest watersheds are normally recognized as sources of high quality water. The forest cover exerts a beneficial regulating influence on the streamflow regime and maintains high water quality by protecting against erosion and sedimentation, increased overland flow, leaching of nutrients, and excessive heating of the water.

Seven forest ecoregions have been described (Loucks, 1961) in New Brunswick. These ecoregions make up 92% of the land, of which 55% is privately owned. As a major industry in the province, the harvesting of the forests centres on the softwood species concentrated in certain watershed sub-basins.

The environmental impact of the forest activities has received a great deal of research attention over the last 30 years. Most of this attention has focused on two parameters: water temperature and turbidity. Other concerns were related to nutrient losses following timber harvesting and slash and burn operations. These processes may adversely affect stream water quality by accelerating the eutrophication process.

3.1.2.2 Impact of Forestry on Water Quality

3.1.2.2.1 Removal of Forest Cover

The removal of the forest cover has an impact on a number of natural processes. It increases runoff out of the basin, accelerates erosion and sedimentation, increases nutrient discharge, and raises ambient water temperatures of the receiving waters.

The clear-cutting and harvesting of forest areas adjacent to water bodies affects the available shading required to maintain cool water temperatures, especially in small streams. The resultant increase of water temperature influences the dissolved oxygen solubility within the receiving water and the solubility characteristics of certain ionic compounds. These changes influence the productivity of major game fishes (speckled trout and Atlantic salmon), which require cold water habitats and high dissolved oxygen levels.

3.1.2.2.2 Loss of Soil Cover

The construction of access roads, the effects of logging machinery on the forest floor, and the deliberate scarring of the soil to discourage regrowth of unwanted tree species all influence the degree of forest floor erosion and subsequent sedimentation and nutrient loss to the receiving waters. The main result of exposing forest soils is the loss of various components to streams and the accelerated leaching of various minerals into lower soil horizons. Data from the Nashwaak watershed and other experimental basins show increases in stream discharges and sediment loads, as well as in some major ions and nutrients, such as nitrogen and phosphorous.

3.1.2.2.3 Forest Fires

A number of studies have examined the specific effects of forest fires or other burning activities on receiving water quality. These studies have shown that forest fire, and slash and burn activities can cause temporary changes in the chemistry of surface soil and percolating waters, including increased phosphorus, exchangeable bases, and total salts, and on alkaline shift in pH. Following burning activity, increased watershed erosion, combined with more alkaline recharge water, has been shown to be responsible for the alkaline shift in pH conditions that is observed in many surface-water systems.

3.1.2.2.4 Storage and Transport of Wood in Water Bodies

Wood floatage has not been practised on inland waters in New Brunswick since the early 1970s, although long-term environmental impacts are still evident. The sedimentation and decomposition of the wood and bark chips on lake and river bottoms have exerted higher chemical and biological oxygen demands. This influence modifies the benthic community structure and fisheries spawning grounds and rearing habitats, and impedes fish migration.

3.1.2.3 Analysis of Data Base

The only basin with data appropriate for the assessment of forestry impact on water quality was the Miramichi River basin. The stations chosen for the assessment are listed in Table 3.2.

Stations OONB01BP0001, OONB01B00007, and OONB01B00019 showed the greatest water quality changes. These sites were located downstream from cutting activity. In most cases, mean values for sodium, magnesium, potassium, and alkalinity do not vary a great deal from station to station, but the annual ranges in these parameters were much greater at the

Table 3.2. Water Quality Stations in the Miramichi River Basin Potentially Affected by Logging Practices

Station	Comments
OONB01BN0001	Cains River Watershed - major cutting activity
OONB01BP0001	Little Southwest Miramichi - major cutting activity
OONB01B00007	Small watershed - major forestry influence
OONB01B00019	Small watershed - major forestry influence, part of it burnt over
OONB01BQ0029	South Sevogle River - cutover area
OONB01BQ0030	South Sevogle River - cutover area
OONB01BM0002	Small watershed, Juniper area - far downstream from cutover area
OONB01BM0003	Small watershed, Juniper area - far downstream from cutover area
OONB01BM0001	Southwest Miramichi - large drainage, downstream from cutover area

mentioned three sites than the other stations listed in Table 3.2. In the case of ammonia, station OONB01B00007 clearly shows mean values higher than those in the other basins.

Station OONB01B00019 was the only site studied that could have been affected by forest fires. It showed a higher mean alkalinity level than the other sites, though pH values were not affected.

3.2 Point Sources

The existing industrial activities contributing major pollution loads to the aquatic environment in New Brunswick consist of food processing and pulp and paper manufacturing. Pollution loads from these two sources are normally high in organic matter. Additional sources of organic carbon include municipal discharge, photosynthesis within the aquatic environment, decomposition of naturally occurring plant and animal materials, and runoff from agricultural lands.

The measurement of total organic carbon can be used to monitor the efficiency of water-treatment systems and as an indicator of potential health hazards. Other conventional parameters that are used to describe pollution loads from waste discharges are biochemical oxygen demand (BOD) and suspended solids. These combined with the TOC values are used to assess the water quality impact of waste loads from the two aforementioned industrial activities.

3.2.1 Food Processing

The food-processing industry has a raw waste effluent that is extremely high in soluble organic matter. Even the smallest plant is likely to have waste loads equivalent to a population of 15 000 to 25 000 people (Lund, 1971). Degradation of a stream results if the balance between oxygen input and consumption is disrupted by large organic loads. Ironically, food-processing waste can provide the nutrients and food necessary to the growth of a variety of organisms, including fish.

Variations in the quantity and type of organic wastes and suspended solids discharged from a processing operation depend very heavily on the use and reuse of water in each plant, the layout of the plant, and the manner in which foods are handled.

A review of the major sources of water pollution from food processing industries in the United States (SRI International, 1979) concluded that the food-processing industries are major industrial sources of water pollutants as indicated by the conventional parameters of BOD and suspended solids.

3.2.1.1 Poultry Products

The basic poultry operations consist of receiving, storing, killing, defeathering, eviscerating, packing, and freezing. The receiving and storing of poultry creates a great deal of waste from manure, unconsumed feed, and water used to wash down cages and storage floor areas. The poultry blood is reported to contain more than 90 000 mg/L BOD (MONENCO, 1969). A tremendous reduction in waste loads can be achieved when blood is collected and removed separately to a by-product or rendering plant. Wastes are often treated in this way in the Maritime provinces (MONENCO, 1969). A 90% collection of blood reduces the BOD of the wastewater by 30%.

Screening of the wastewater before it is discharged to municipal sewers is the major treatment carried out in poultry plants located in the Maritimes. An example of screened wastewater characteristics of the industry in the Maritimes is shown in Table 3.3

Table 3.3. Screened Wastewater Characteristics of a Poultry Plant

BOD (mg/L)	COL (mg/L)	Total solids (mg/L)	Chlorine (mg/L)	pH
600	452	268	50	5.5

3.2.1.2 Meat Processing

The slaughtering and meat-processing industry is not large in New Brunswick, but there is potential for extensive pollution from plant wastes where untreated discharge is released into receiving waters (MONENCO, 1969). The volume of organic content of meat wastes varies according to the type of operation and the degree of by-product recovery practice (Lund, 1977). Blood from the killing operations typically has BODs of 100 000 mg/L. In addition, paunch manure adds considerably to BOD and suspended solids in liquid wastes.

Variations in the quantity of water required and wastewater characteristics are generally due to the types of sub-processes employed by the various plants. The relevant processes are blood recovery, paunch handling, edible rendering, inedible rendering, and cleanup. Table 3.4 gives the range of waste loads in the meat-processing industry.

Table 3.4. Waste Loads per 100 kg Live Weight Slaughtered

	Waste (L)	BOD (kg)	Suspended solids (kg)
Range	9,100-35,000	8.0-23.5	6.3-22.1
Average	14,000	15.0	14.0

Source: Scott *et al.*, 1966.

In the Maritimes, primary and secondary settling ponds or lagoons are the main form of treatment used. Most plants, however, discharge their wastes to municipal sewers without treatment (MONENCO, 1969). Table 3.5 gives the range of waste flows and the concentrations of waste waters from meat products plants.

Table 3.5. Waste Flows and Concentrations from Meat Products Plants per 100 kg Live Weight Slaughtered

Operation	Waste flow (L)	BOD (mg/L)	Suspended Solids (mg/L)	Grease (mg/L)
Slaughterhouse	450-1820	650-2200	930-3000	200-1000
Packinghouse	640-3210	230-3000	230-2000	200-1000
Processing Plant	910-3740	200-800	200-300	100-300

Source: Public Health Service, 1965.

3.2.1.3 Dairy Products

Most dairy plants consist of several operations such as receiving stations, bottling, creameries, and manufacturing of ice cream, cheese, and condensed and dried milk products. In the Maritimes, controlling product losses has improved yield and efficiency and at the same time has reduced waste pollution problems. The major plants in the Maritimes all carry out good recovery of buttermilk and whey. The whey is usually dried for stock feed (MONENCO, 1969). The treatment of milk wastes is normally handled through municipal plants (Lund, 1971). Plants in areas not serviced by municipal sewers, however, generally discharge untreated wastewater into nearby rivers.

The wastewater characteristics of sample dairies in the Maritime provinces are shown in Table 3.6.

Table 3.6. Wastewater Characteristics of Sample Dairies in the Maritime Provinces

	Range	Average
BOD (mg/L)	360-612	454
COD (mg/L)	81-1050	705
Total solids (mg/L)	73-3024	1000
pH	-	5.0

Source: New Brunswick Research and Productivity Council, 1965.

3.2.1.4 Fruits and Vegetables

Large amounts of solids are found in the wastewaters of fruit- and vegetable-processing plants. Major sources of suspended solids include the washing of food products, spillage of food and ingredients, and the washing of floors and all other areas. The liquid portion of the waste is normally screened as a first step in any treatment process. Solids from the screenings can be collected with the other solids and removed from the plant in a relatively dry state (Lund, 1971).

Liquid waste can be difficult to handle. BOD varies a great deal, but on average, for several products it is approximately 10 times the strength of domestic sewage (MONENCO, 1969). Food-processing wastes are amenable to treatment by biological methods. Most fruit-processing plants in the Maritimes, however, discharge wastewater without treatment, but pose relatively minor problems due to the low volumes discharged (MONENCO, 1969).

3.2.1.5 Potato Starch

New Brunswick had a few potato starch plants in operation during the period 1960-80. The starch extraction process is a simple one that includes washing the potatoes; grinding and screening; removing protein water, grit, and brown starch; washing the starch; and dewatering and drying the finished product. Table 3.7 shows the waste quantities at two New Brunswick starch plants.

Table 3.7. Waste Quantities at Two New Brunswick Starch Plants

	Daily flow		BOD washing and process waste
	Washing	Process	
Plant A	1 600 000 L	320 000 L	2540 mg/L
Plant B	1 100 000 L	360 000 L	2950 mg/L

Source: MONENCO, 1969.

Starch wastes have a population equivalent of 1600 to 3000 persons per day. One New Brunswick plant operating at full capacity would have an average polluting effect of between 20 000 and 36 000 people. Table 3.8 shows the wastewater characteristics of a typical potato starch plant.

Table 3.8. Wastewater Characteristics of a Potato Starch Plant

	BOD (mg/L)	COD (mg/L)	Total solids (mg/L)	pH
Total effluent	730	743	4 170	5.0
Protein water	n.a.	6 330	7 630	4.0
Pulp from shaker screen	11 100	31 750	32 180	4.0
Water from washing of starch	973	1 021	13 310	6.5

n.a. - not applicable

Source: New Brunswick Research and Productivity Council, 1965.

Ten percent of the potato is starch, while the remaining 90% is pulp and protein water, which is wasted or used as a by-product. New Brunswick potato starch producers use the pulp waste to make a dry stock feed. This reduces the effluent loading by as much as 45%. The protein water is normally discharged without treatment into the river.

3.2.1.6 Brewing

The brewing industry uses water for production and processing purposes. On average, Maritime breweries use more water to produce a litre of beer than do plants in Ontario and the United States.

The processing water normally contains the wastes from several different operations. The five-day BOD for most breweries ranges between 420 and 1200 mg/L; suspended solids range between 200 and 500 mg/L; and pH values range between 5.5 and 7.4. Brewery wastes, which consist of grain, mash, and hops waters, are usually discharged into municipal sewer systems. Table 3.9 shows the wastewater characteristics of breweries in the Atlantic region.

Table 3.9. Wastewater Characteristics of Breweries in the Atlantic Region

	<u>Range</u>	<u>Average</u>
Biochemical oxygen demand (mg/L)	3130- 40 300	7 130
Chemical oxygen demand (mg/L)	24-174 500	40 000
Total solids (mg/L)	10- 99 700	19 390
Chloride value (mg/L)	9- 534	115
pH	4.5- 6.5	5.4

Source: New Brunswick Research and Productivity Council, 1965.

3.2.1.7 Soft Drinks

Wastewaters from soft drink plants are generally alkaline and moderately high in both suspended solids and BOD. Apart from spillage and plant cleanup, waste results from the pre-rinse and final rinse of bottles and the cleaning of the syrup mixing tank, syrup feed storage tank, and syrup filters. Daily production is greatest from June to September. This approximates yearly low stream flow periods and when both water use and effluent loads are 25% to 50% above normal.

Industry surveys suggest that about 80% of wastewaters from Maritime plants discharge wastewaters into municipal sewer systems. Little if any wastewater is treated prior to discharge from the plant. The characteristics of wastewaters from Maritime soft drink plants are presented in Table 3.10.

Table 3.10. Wastewater Characteristics of Soft Drink Plants in the Maritime Provinces

	<u>Range</u>	<u>Average</u>
BOD (mg/L)	33 - 132	77
COD (mg/L)	15 - 338	147
Total solids (mg/L)	178 - 544	348
Chlorine (mg/L)	5 - 11	9.5
pH	5.0 - 5.5	5.2

Source: New Brunswick Research and Productivity Council, 1965.

3.2.1.8 Interpretation

(a) Sub-basin OIAD

Water quality data for sub-basin OIAD was obtained from five stations monitored between 1965 and 1979. A total of 166 sample analyses were utilized to evaluate the degree to which surface waters were affected by organic wastes. Total organic carbon (TOC) was used to determine the state of degradation of individual streams within the sub-basin. Table 3.11 gives the median, low, and high TOC concentrations for each station.

Table 3.11. TOC Comparison - Upper Saint John River

Station	No. of samples	TOC (mg/L)			Location
		Med.	Low	High	
OONB01AD0013	39	6.5	0.5	18.0	St. Francis River
OONB01AD0001	81	9.4	2.1	34.0	SJR at Clair
OONB01AD0014	13	10.0	3.6	20.0	SJR at Edmundston
OONB01AD0015	25	7.0	0	11.4	Madawaska River at Quebec border
OONB01AD0012	8	6.9	0.5	9.0	Madawaska River below St. Jacques

Note: SJR means Saint John River.

Organic inputs to the St. Francis River are not strongly reflected by TOC levels at station OONB01AD0013. At 6.5 mg/L, this station has the lowest median TOC concentration in the sub-basin. Background TOC levels of less than 10 mg/L have been observed in areas of New Brunswick uninfluenced by large organic inputs. Low (0.5 mg/L) and median (6.5 mg/L) TOC concentrations indicate that the St. Francis River has the capacity to assimilate most organic inputs that it is receiving.

Station OONB01AD0001 is situated downstream from the St. Francis River on the main stem of the Saint John River at the Clair bridge. Median, low, and high TOC levels are 9.4, 2.1, and 34.0 mg/L, respectively. Anthropogenic sources of organic carbon tend to increase in the downstream direction and are reflected by the rise in TOC levels between stations OONB01AD0013 and OONB01AD0001.

The median TOC concentration increased from 6.5 mg/L at station OONB01AD0013 to 9.4 mg/L at station OONB01AD0001. This corresponds to an increase of 2.9 mg/L or a rise of 31% between stations. Similarly, the low and high TOC concentrations rose from 0.5 mg/L to 2.1 mg/L and from 18.0 mg/L to 34.0 mg/L (76% and 47%, respectively).

Water quality in the main stem of the Saint John River tends to deteriorate as anthropogenic sources of organic wastes are encountered. There are three obvious sources of organic wastes in the vicinity of station OONB01AD0001: the village of St. François-de-Madawaska, Nadeau Poultry Farm Ltd., and the village of Clair. However, organic wastes from these sources are handled by three municipal sewage treatment facilities: two at Madawaska and one at Clair. A modest 0.6-mg/L increase in the median TOC at the downstream station OONB01AD0014 reflects, at least in part, the effectiveness of urban and industrial waste treatment. Other positive signs include a reduction in the peak TOC concentration from 34 mg/L to 20 mg/L. The minimum TOC rose to 3.6 mg/L at station OONB01AD0014. Table 3.12 compares the changes in TOC levels observed at stations OONB01AD0001 and OONB01AD0014.

Table 3.12. TOC Comparison - Sub-basin 01AD

Station	TOC (mg/L)		
	Med.	Low	High
OONB01AD0001	9.4	2.1	34.0
OONB01AD0014 (% change)	10.0 (+6.4)	3.6 (+41.7)	20.0 (-83.0)

The TOC levels dropped by 83% from a high of 34.0 mg/L at station OONB01AD0001 to 20.0 mg/L at station OONB01AD0014. This suggests that water quality deterioration slowed in the downstream direction.

Stations OONB01AD0015 and OONB01AD0012 are situated on the Madawaska River. The water quality of this river is considered good when assessed on the basis of organic loading. Median and low TOC levels are low at both stations and closely approximate the levels observed for the St. Francis River. A similar situation exists for peak TOC levels.

(b) Sub-basin 01AF

Seven stations were assessed in sub-basin 01AF in terms of TOC. These are listed in Table 3.13. The median TOC concentration for the 308 samples analyzed was 10.7 mg/L.

Table 3.13. TOC Comparison - Sub-basin 01AF

Station	TOC (mg/L)			Location
	Med.	Low	High	
OONB01AF0016	4.9	2.0	21.0	Green River
OONB01AF0003	4.6	4.5	10.0	Salmon River
OONB01AF0006	4.0	0.5	83.0	Black Brook
OONB01AF0001	7.0	0.5	30.0	Little River
OONB01AF0002	16.4	2.5	47.5	SJR at St. Leonard
OONB01AF0022	18.0	1.0	49.3	SJR at Grand Falls headpond
OONB01AF0005	16.0	3.4	38.5	SJR at Limestone

Note: SJR means Saint John River.

Water quality deteriorates rapidly in sub-basin 01AF as it moves downstream from Edmundston. Fraser Inc. was one of the largest single dischargers of waste above Westfield. Several other human activities also contributed substantial amounts of TOC between Edmundston and Aroostook Junction. Food processing takes place at McCain Foods in Grand Falls, and Valley Co-Op is also located in the area. The Grand Falls Industrial Park has woodworking operations and Piers Piggery is located on the Little River above Grand Falls.

The three major tributaries to the Saint John River in sub-basin 01AF are the Green, Little, and Salmon rivers. Median TOC concentrations for the Green and Salmon rivers generally reflected organically clean aquatic conditions that approximated expected background levels. Black Brook and the Little River had median TOC concentrations of 4.0 and

7.0 mg/L, which is relatively good, but the former had a peak TOC concentration of 83 mg/L, which is indicative of periodic stress. It is not possible to accurately identify the cause of elevated peak TOC concentrations in Black Brook. Several potential sources include the abandoned McCain Foods dump site and their retention ponds located near St. Andre, or more likely the unserved community at St. Andre itself.

Peak TOC concentrations from the Little River reached 30 mg/L at station OONB01AF0001, but the median is only slightly elevated at 7.0 mg/L.

Elevated TOC levels were recorded at stations OONB01AF0002, OONB01AF0022, and OONB01AF0005. Median instream TOC levels rose from 16.4 mg/L at St. Leonard to 18.0 mg/L at Grand Falls, after which it dropped to 16.0 mg/L at Limestone. Peak TOC concentrations vary between 49.3 mg/L and 38.5 mg/L. One major source of organic loading at Grand Falls is the McCain Foods processing operation. Overall peak TOC levels increased by 27.5 mg/L in the Saint John River between Edmundston and St. Leonard.

A 10-mg/L drop in the peak TOC concentration between Grand Falls headpond and Limestone reflects the absence of major organic inputs into this section of the Saint John River. Organic pollution, although improving in the downstream direction below the headpond, is still evident because peak (38.5 mg/L) and median (16.0 mg/L) TOC levels are high.

(c) Sub-basin 01AG

The Aroostook River is located almost entirely in the State of Maine, but discharges from sub-basin 01AG into the Saint John River above Perth-Andover. During the study period, the river accepted waste discharges with large BOD values from several municipalities, a starch plant, and four major potato-processing plants.

Water quality data were derived from 149 samples collected from three stations. These are listed in Table 3.14 along with their TOC values.

Table 3.14. TOC Comparison - Sub-basin 01AG

Station	TOC (mg/L)			Location
	Med.	Low	High	
OONB01AG0003	7.0	0.5	86.5	Limestone River at Four Falls
OONB01AG0008	10.0	1.0	20.0	Aroostook River above Limestone River
OONB01AG0009	8.8	5.0	15.8	Aroostook River at Tinker dam

In general, median TOC levels from all three stations are relatively high. The minimum TOC of 5.0 mg/L is an indicator that water quality in the Aroostook River was poor. For example, the effect of organic loading, as measured by minimum TOC values, is normally more pronounced on the main stem of the Saint John River than in tributary systems. However, the minimum TOC value on the Aroostook River at station OONB01AG0009 is elevated with respect to all other stations located upstream on the Saint John River. During the study period, the Aroostook River was a major source of organic carbon to the Saint John River.

(d) Sub-basin 01AH

The Tobique River drains sub-basin 01AH and is a major tributary to the Saint John River. The only station in this system is located in the headwaters at Riley Brook (OONB01AH0002).

Based on available data, water quality in the upper reaches of the Tobique River is good. The median, minimum, and maximum TOC concentrations were 4.0, 2.5, and 12.7 mg/L, respectively.

(e) Sub-basin 01AJ

The main waters in sub-basin 01AJ are the Saint John, Presquile, and Meduxnekeag rivers. TOC measurements were made in all three rivers (Table 3.15).

Table 3.15. TOC Comparison - Sub-basin 01AJ

Station	TOC (mg/L)			Location
	Med.	Low	High	
OONB01AJ0002	14.0	0.5	29.5	SJR at Perth-Andover
OONB01AJ0011	12.8	1.0	25.5	SJR above Florenceville
OONB01AJ0009	11.0	0.5	29.0	SJR below Florenceville
OONB01AJ0012	5.2	0.5	25.5	Presquile River at international border
OONB01AJ0006	7.0	0.5	22.5	Presquile River at Tracey Mills
OONB01AJ0013	10.5	3.0	30.0	SJR at Hartland
OONB01AJ0029	7.1	3.0	15.3	Meduxnekeag River at Mill Stream
OONB01AJ0015	6.6	2.0	20.1	Meduxnekeag River at Belleville
OONB01AJ0014	12.5	0.5	26.5	SJR at Woodstock

Note: SJR means Saint John River.

The compounding effects of upstream organic loading plus sewage input from Perth-Andover is reflected in the TOC values for station OONB01AJ0002. Station OONB01AJ0011 has TOC values that demonstrate the accumulation of organic loads from upstream sources, whereas station OONB01AJ0009 reflects sources above Florenceville and from Florenceville itself. The two major sources of discharge in Florenceville are the Carleton Co-Op and McCain Foods.

Sub-basin 01AJ has two sources of organic carbon below Florenceville: the Presquile and Meduxnekeag rivers. The Presquile River drains approximately 600 km², part of which is in the United States. Water quality data were collected from two stations on the Presquile River: OONB01AJ0012 and OONB01AJ0006. The maximum TOC concentration of 25.5 mg/L at station OONB01AJ0012 suggests that human activities contributed large amounts of TOC to the river. The data from the other station collaborate this.

A sewage treatment facility is operated a few kilometres downstream from the Presquile River at Hartland. Water quality was monitored at station OONB01AJ0013 on the main stem of the Saint John River above the town. TOC concentrations ranged between 3.0 and 30.0 mg/L at Florenceville. The median TOC concentration dropped slightly between Florenceville and Hartland to 10.5 mg/L from 11.0 mg/L.

The Meduxnekeag River drains 1335 km² and discharges into the Mactaquac headpond several kilometres downstream from Hartland. There are two stations on the river and one at the confluence with the Saint John River.

The TOC from the United States was slightly elevated, but low compared to the Presquile. The town of Woodstock is located at the confluence of the Meduxnekeag with the Saint John River. Water quality at station OONB01AJ0014 is affected by organic wastes from sources on both rivers. The median TOC concentration was 12.5 mg/L, up from 10.5 mg/L at Hartland and 7.1 mg/L at station OONB01AJ0029 on the Meduxnekeag River. A maximum TOC concentration of 26.5 mg/L is elevated with respect to the Meduxnekeag River, but is consistent with most maximum TOC levels measured at upstream stations affected by human activities.

(f) Sub-basin 01AK

Below Woodstock, the Saint John River flows into sub-basin 01AK. The area located between the town of Woodstock and the Mactaquac headpond is sparsely populated and water quality data are scarce. More than 1000 people live near the Ste-Anne-Nackawic Pulp and Paper mill, which is serviced by a waste treatment facility. Compared to Frasers of Edmundston, the Ste-Anne-Nackawic mill discharges much smaller amounts of TOC per day.

Station OONB01AK0001, on the Saint John River near the former McKinley Ferry landing, had a median six-year TOC value of 10.7 mg/L, down by nearly 2 mg/L from Woodstock. Its six-year maximum TOC of 15.5 mg/L was down from the 26.5 mg/L reported at Woodstock. Discharges from the Ste-Anne-Nackawic Pulp and Paper mill does not severely affect the organic content of water at station OONB01AK0001 and is not expected to grossly modify water quality in the Mactaquac headpond.

Two water quality stations are located on the North Nashwaaksis Stream, a small tributary to the Saint John River. Both stations, OONB01AK0003 and OONB01AK0002, had TOC levels that showed signs of moderate organic inputs from anthropogenic sources (Table 3.16).

Table 3.16. TOC Comparison - Sub-basin 01AK

Station	TOC (mg/L)			Location
	Med.	Low	High	
OONB01AK0002	7.2	0.5	13.3	North Nashwaaksis Stream at Royal Road
OONB01AK0003	6.0	2.8	13.3	North Nashwaaksis Stream at Sandwith farm
OONB01AK0001	10.8	4.0	15.5	SJR at McKinley Ferry
OONB01AK0030	15.0	9.3	25.0	SJR below Fredericton

Note: SJR means Saint John River.

Station OONB01AK0003 had an eight-year median TOC concentration of 6.0 mg/L, a minimum of 2.8 mg/L, and a maximum of 13.3 mg/L. Median and maximum TOC values were similar to those expected from most other tributary streams in the province. However, the 2.8 mg/L minimum TOC concentration, although not seemingly high, more closely approximates those streams with moderately stressed assimilative capacities.

The seven-year median TOC value at station OONB01AK0002 was 7.2 mg/L, up slightly from the 6.0 mg/L recorded at station OONB01AK0003. An accumulation of upstream organic

carbon from human activities is likely responsible for the increase. In summary, the North Nashwaaksis Stream did not appear to adversely affect the overall quality of water in the main stem of the Saint John River.

(g) Sub-basin 01AL

The Nashwaak River is central to surface drainage in sub-basin 01AL. TOC levels in the upper reaches of the sub-basin were monitored at station OONB01AL0006. Station OONB01AL0007 monitored TOC values at the mouth of the Nashwaak River. Unfortunately, the quality of water immediately prior to waste discharge at Fredericton is unknown. Station OONB01AL0008 shows water quality on the Dunbar Stream, a tributary to the Nashwaak River between stations OONB01AL0006 and OONB01AL0007. A record of TOC levels is given in Table 3.17.

Table 3.17. TOC Comparison - Sub-basin 01AL

Station	TOC (mg/L)			Location
	Med.	Low	High	
OONB01AL0006	5.7	2.0	13.3	Nashwaak River at bridge
OONB01AL0008	5.2	2.8	8.7	Dunbar Stream above confluence with Nashwaak River
OONB01AL0007	4.9	1.2	22.1	Nashwaak River at Barkers Point

Median TOC values reflect the relative intensity of human settlement in this sub-basin. The headwater areas of the Nashwaak River basin are moderately populated above station OONB01AL0006. TOC concentrations ranged between 2.0 to 13.3 mg/L, with a median of 5.7 mg/L.

The TOC content of water from Dunbar Stream was generally lower but similar to that observed in headwater areas. Dunbar Stream has fewer inhabitants in its environs than does the Nashwaak River.

An increase in land development in the downstream direction towards Fredericton is expected to deteriorate water quality in the Nashwaak River. Station OONB01AL0007 represents water quality after purification in Fredericton's municipal sewage treatment facilities.

The median TOC concentration at station OONB01AL0007 was 4.9 mg/L, down from the upstream stations by 0.8 and 0.3 mg/L. The minimum TOC value of 1.2 mg/L (OONB01AL0007) was also lower than those values reported for the upstream stations.

(h) Sub-basin 01AM

The Oromocto River drains much of the 2015 km² of sub-basin 01AM. Thirteen water quality samples were collected between 1965 and 1978 at station OONB01AM0003 near the mouth of the Oromocto River. The 13-year median TOC was 8.2 mg/L and the range was 3.6 to 14.7 mg/L. Human activity has deteriorated water quality in the Oromocto River.

(i) Sub-basins 01AN and 01AO

The Salmon River had three water quality stations from which chemical and physical data were collected. Surface drainage from sub-basin 01AN flows into Grand Lake by way of the Salmon River. Grand Lake occupies a large portion of sub-basin 01AO and also receives drainage from the Little River and Newcastle Creek. Data from these two streams, however, are limited. The Jemseg River, located at the lower end of Grand Lake, discharges into the Saint John River and provides an exit for surface drainage from sub-basins 01AO and 01AN. Table 3.18 summarizes the TOC levels obtained.

Table 3.18. TOC Comparison - Sub-basins 01AN and 01AO

Station	TOC (mg/L)			Location
	Med.	Low	High	
OONB01AN0001	9.2	5.6	24.6	Salmon River at Gaspereau Forks
OONB01AN0007	5.0	3.0	54.6	Iron Bound Cove Stream above coal wash plant
OONB01AN0002	8.3	0.5	2350.0	Iron Bound Cove Stream at hwy bridge
OONB01AN0003	4.0	2.0	27.5	Iron Bound Cove Stream at lower causeway
OONB01AN0005	10.5	4.0	16.0	Salmon River at Chipman bridge
OONB01AN0010	9.6	4.7	23.0	Salmon River at O'Leary Ferry Crossing
OONB01A00015	12.0	6.0	18.5	Cumberland Bay at hwy bridge
OONB01A00008	9.0	5.0	17.0	Newcastle Creek at causeway
OONB01A00009	9.2	3.0	13.0	Drainage from Princess Park to Grand Lake
OONB01A00011	11.8	6.0	10.5	Unnamed stream between French Lake and Maquapit Lake
OONB01A00003	7.9	3.0	10.5	Jemseg River at old bridge abutment
OONB01A00004	9.5	3.0	17.0	Saint John River at Burton bridge

Water quality above Chipman (OONB01AN0001) was poor. The median and maximum TOC concentrations, which approached 10 and 25 mg/L, and a lack of industrial activity above the site, suggest poor waste assimilation along this segment of the Salmon River. Even the minimum TOC of 5.6 mg/L was higher than almost all the sub-basins in the province.

Station OONB01AN0005 is situated downstream from station OONB01AN0001 at Chipman bridge. The community of Chipman has municipal sewage treatment facilities for its population of nearly 2000 people. The minimum and maximum TOC values at this station ranged between 4.0 and 16.0 mg/L. However, the median TOC rose by 1.3 mg/L from 9.2 mg/L at OONB01AN0001. Changes in TOC concentrations in this reach of the Salmon River are influenced by domestic waste discharges rather than industrial inputs.

Station OONB01AN0010 is further downstream on the Salmon River at the inlet to Grand Lake. Minimum and maximum TOC concentrations rise as the water flows from station OONB01AN0005 to OONB01AN0010.

Iron Bound Cove Stream is a tributary to the Salmon River. Water quality was monitored at three sites along its course: OONB01AN0007, OONB01AN0002, and OONB01AN0003.

Water quality, with respect to TOC, was generally good at station OONB01AN0007. The median TOC value (5.0 mg/L) compares favourably with levels observed in many provincial streams and the minimum TOC level was 3.0 mg/L. However, the quality of water has been

adversely affected, possibly by coal wash effluent derived from the New Brunswick Coal Wash Plant at Minto. Station OONB01AN0007 recorded a maximum TOC concentration of 54.6 mg/L, and moreover, 10% of the time the TOC approached 30.0 mg/L.

Station OONB01AN0002 is located downstream from the New Brunswick Coal Wash Plant at Minto. The TOC levels recorded at this station are the highest observed in the province. The median TOC was 8.3 mg/L and the minimum was 0.5 mg/L, suggesting a good overall assimilative capacity. However, a staggering 2350 mg/L maximum TOC was also recorded at this station. Organic inputs above station OONB01AN0002 generated TOC levels of more than 760 mg/L 10% of the time and more than 273 mg/L 25% of the time.

Station OONB01AN0003 is situated below station OONB01AN0002 on Iron Bound Cove Stream, and as can be seen, the water quality at this station is considerably improved over the latter.

There are insufficient data from station OONB01AN0010 to properly assess the degree to which TOC from Iron Bound Cove Stream affects the Salmon River.

Table 3.18 lists the four water quality stations situated in streams that drain sub-basin O1A0 into Grand Lake. These are OONB01A00015, OONB01A00008, OONB01A00009, and OONB01A00011. The data from these stations indicate that TOC concentrations were similar in magnitude and approached what may be termed background levels.

The community of Minto is situated above station OONB01A00008 on Newcastle Creek. The treated municipal sewage, however, does not appear to adversely affect the downstream water quality. The TOC content of water in the Jemseg River (OONB01A00003) may or may not reflect the overall organic state of Grand Lake. One can, however, make two statements. First, the Jemseg River had TOC concentrations that were equal to or lower than all other stations in sub-basins O1AN and O1A0. Second, the organic content of water from these two sub-basins is not expected to adversely affect water quality in the main stem of the Saint John River.

(j) Sub-basin O1AP

In sub-basin O1AP, the Saint John River has several important tributaries including the Kennebecasis, the Canaan, the Otnabog, and the Nerepis rivers (Table 3.19).

Table 3.19. TOC Comparison - Sub-basin O1AP

Station	TOC (mg/L)			Location
	Med.	Low	High	
OONB01AP0001	12.0	7.7	26.6	Canaan River at hwy 112 bridge
OONB01AP0021	7.2	4.4	13.1	Otnabog River at hwy 102 bridge
OONB01AP0033	6.0	1.8	16.2	Nerepis River at hwy bridge
OONB01AP0030	2.5	0.6	5.0	Kennebecasis River at TCH bridge
OONB01AP0002	4.4	0.5	24.9	Kennebecasis River at Apohaqui
OONB01AP0034	6.2	1.5	9.5	Kennebecasis River at Hampton

Station OONB01AP0001 on the Canaan River had a median TOC concentration of 12.0 mg/L, with a minimum of 7.7 mg/L and a maximum of 26.6 mg/L. Total organic carbon is derived from both natural sources and domestic sewage. Nearly 1000 people live in the vicinity of Lower Ridge on Ridge Brook, a tributary to the Canaan. The community was not serviced by municipal treatment facilities and may be responsible for the elevated TOC values. The Canaan, however, is not expected to have significant impact on water quality in the Saint John River.

The Otnabog River basin has a sparse population and little industrial activity. The water quality station (OONB01AP0021) is located near the mouth of the river. The median TOC concentration was 7.2 mg/L. Minimum and maximum TOC levels were 4.4 and 13.1 mg/L, respectively. The data seem to indicate that the water quality is generally good.

Station OONB01AP0033 is situated on the Nerepis River above the confluence with the Saint John River. The land area above the station is moderately populated. TOC levels were lower than those reported for the Canaan and Otnabog rivers and considered good.

The Kennebecasis River has three monitoring stations: OONB01AP0030, OONB01AP0002, and OONB01AP0034. The water quality at station OONB01AP0030 is not influenced by urban centres or upstream industrial activities, and its TOC levels are considered background. Further downstream, below Sussex at station OONB01AP0002, the quality changes. The median TOC was 4.4 mg/L and the maximum was 24.9 mg/L, reflecting human activity.

At station OONB01AP0034, the median TOC concentration was 6.2 mg/L, which is a slight increase from station OONB01AP0002. The minimum TOC concentration also showed a slight increase to 1.5 mg/L. The maximum concentration, however, decreased to 9.5 mg/L.

(k) Sub-basin 01AQ

There were only two water quality stations in sub-basin 01AQ for which TOC levels were reported: OONB01AQ0001 and OONB01AQ0002. Station OONB01AQ0001 is located at the mouth of the Lepreau River, while station OONB01AQ0002 is located on the Magaguadavic River at the second falls.

The Lepreau River above station OONB01AQ0001 supports no industrial activity and is virtually uninhabited. The median TOC concentration was 6.0 mg/L, whereas the low and high were 3.9 and 10.0 mg/L, respectively. Some organic waste is present and may be attributable to the small community living in the area of the Lepreau.

The Magaguadavic River is similar to the Lepreau River in that it is virtually uninhabited, however, a tin mine is situated in its headwaters. The TOC concentrations were higher in the Magaguadavic River than in the Lepreau River. The median TOC level at station OONB01AQ0002 was 8.6 mg/L, whereas the low and high were 6.0 and 20.8 mg/L, respectively. Two factors may contribute to these higher levels: a potential for greater organic inputs from a substantially larger drainage area and the land disturbances associated with the mining operations.

(l) Sub-basin 01AR

The St. Croix River is an international boundary river situated within sub-basin 01AR. Long-term water quality records were available for station OONB01AR0002 in the upper central section of the basin, and for station OONB01AR0001 near the mouth of the river.

The median TOC concentration for station OONB01AR0002 was 7.2 mg/L. The minimum and maximum TOC levels were 1.5 and 11.2 mg/L, respectively. These TOC levels reflect the limited degree of anthropogenic influence. The sources of organic matter probably originate from the upstream communities of St. Croix and McAdam.

Station OONB01AR0001 is located at Milltown, a municipality not serviced by waste treatment facilities. The median TOC concentration was 11.5 mg/L, up from 7.2 mg/L reported at the upstream station. The minimum and maximum levels were 1.5 and 16.5 mg/L. This station is affected by domestic wastes from Milltown.

(m) Sub-basin 01BV

Water quality data were available for the Point Wolf and Upper Salmon rivers in sub-basin 01BV. Station OONB01BV0015 is located at the mouth of the Point Wolf River in Fundy National Park, and station OONB01BV0016 is located at the confluence with Kinnie Brook on the Upper Salmon River above Alma. The Point Wolf and Upper Salmon rivers are uninfluenced by domestic or industrial activity and as expected yield low TOC values (Table 3.20). The water quality in both rivers is considered good.

Table 3.20. TOC Comparison - Sub-basin 01BV

Station	TOC (mg/L)			Location
	Med.	Low	High	
OONB01BV0015	3.9	1.5	5.9	Point Wolf River
OONB01BV0016	3.5	2.2	5.6	Upper Salmon River

(n) Sub-basin 01BU

It is not possible to properly characterize water quality in sub-basin 01BU from the available TOC data. The only station with adequate data is OONB01BU0004 located on the Petitcodiac River at the Moncton-Riverview causeway. This station can provide useful information only about gross trends above Moncton-River View.

There are two significant point sources of organic wastes above Moncton on the Petitcodiac River: the communities of Petitcodiac and Salisbury. Petitcodiac has wastewater treatment and disposal for 1400 people, and Salisbury provides the same for a population of 1100.

The median TOC concentration at station OONB01BU0004 was 6.6 mg/L, whereas the minimum and maximum were 2.4 and 20.0 mg/L, respectively. These values are comparable to other streams influenced by domestic sewage from communities of similar size.

(o) Sub-basin 01BS

Sub-basin 01BS has TOC data available from four stations (Table 3.21). These stations are not influenced by urban centres of industrial activity, however, the sub-basin is moderately populated in the coastal area.

Total organic carbon concentrations in the Richibucto River basin were monitored at stations OONB01BS0046 and OONB01BS0001. The median TOC levels were 10.2 and 7.5 mg/L, respectively. The organic nature of surficial materials, such as peat moss, is likely responsible for these levels. Minimum and maximum TOC concentrations were at levels that

might be expected from drainage areas having large amounts of naturally occurring organic materials. Similar conclusions may be drawn for the results obtained for the Buctouche and Cocagne rivers.

Table 3.21. TOC Comparison - Sub-basin O1BS

Station	TOC (mg/L)			Location
	Med.	Low	High	
OONB01BS0001	7.5	3.5	15.0	Coal Branch River at Beersville
OONB01BS0046	10.2	2.4	17.6	Richibucto River at Smiths Corner
OONB01BS0018	12.7	3.3	21.1	Buctouche River at Coates Mills
OONB01BS0019	10.9	5.1	17.4	Cocagne River at Notre-Dame

(p) Sub-basin O1BR

Sub-basin O1BR is primarily drained by the Kouchibouguac River. Water quality in this river is not influenced by urban drainage or industrial wastes. Several hundred people reside in the upper section above station OONB01BR0001. The lower portion has a substantially smaller population. This explains why the upper section has higher TOC levels than those observed at station OONB01BR0011 (Table 3.22).

Table 3.22. TOC Comparison - Sub-basin O1BR

Station	TOC (mg/L)			Location
	Med.	Low	High	
OONB01BR0001	11.2	7.0	18.7	Kouchibouguac River at Vautour
OONB01BR0011	7.5	2.4	17.8	Kouchibouguac River Hwy 11

(q) Miramichi River Basin

The Miramichi River basin includes the following sub-basins: O1BM, O1BN, O1BO, O1BP, and O1BQ. Deforestation and base metal mining may cause some organic loading at a few locations, however, this is not overly significant due to the distance between these activities. In most cases, because of its size, the Miramichi River is able to assimilate most intermittent organic inputs from these two activities without a large rise in TOC levels. TOC levels are summarized in Table 3.23.

Sub-basin O1BM contains only one station, OONB01BM0001, situated at the lower end of the Southwest Miramichi River. The Southwest Miramichi River drainage area is virtually uninhabited except for a few hundred people living immediately above the station. From the TOC data generated, it would appear that the river is able to assimilate the organic wastes resulting from these inhabitants.

The Cains River, although uninhabited, drains through a number of peat areas and is expected to have slightly elevated TOC levels. The median TOC level confirms this expectation.

Table 3.23. TOC Comparison - Miramichi River Basin

Station	TOC (mg/L)			Location
	Med.	Low	High	
OONB01BM0001	5.0	3.9	16.2	Southwest Miramichi River at Bloomfield Ridge
OONB01BN0001	8.0	4.1	13.5	Cains River at Southwest Miramichi River confluence
OONB01B00001	6.5	1.0	12.4	Southwest Miramichi River at Blackville
OONB01B00002	6.4	3.4	15.8	Renous River above confluence of McGraw Brook
OONB01B00013	7.1	4.3	13.4	Renous River at Renous
OONB01B00007	9.5	8.0	28.2	Barnaby River at Barnaby River
OONB01B00019	5.7	0.5	13.5	Bartibog River at Bartibog
OONB01BP0001	5.5	2.3	14.0	Little Southwest Miramichi River at Lyttleton
OONB01BQ0056	3.6	2.5	8.9	Northwest Miramichi River at Hwy 430
OONB01BQ0044	4.5	2.5	9.3	Northwest Miramichi River at Wayerton
OONB01BQ0008	6.1	4.1	13.7	Sevogle River at confluence of Northwest Miramichi River
OONB01BQ0001	5.6	2.9	19.1	Northwest Miramichi River at Redbank

Water quality data were available for several rivers in sub-basin 01B0. These rivers include the main stem of the Southwest Miramichi, the Renous, the Barnaby, and the Bartibog.

Station OONB01B00001 is located on the Southwest Miramichi River in Blackville at the confluence with the Bartholomew River. The median TOC level was 6.5 mg/L, which is similar to the upstream station OONB01BM0001. Minimum and maximum TOC values were also low and remained close to those values observed at stations uninfluenced by continuous, long-term organic inputs.

The Renous River, which is uninhabited, enters the Miramichi River at Renous, several kilometres downstream from station OONB01B00001. There are two stations on the Renous River: OONB01B00002 above the confluence with McGraw Brook and OONB01B00013 near the mouth of the Renous River. The median TOC level at station OONB01B00002 was 6.4 mg/L, slightly lower than the 7.1 mg/L at station OONB01B00013. Similarly the minimum TOC concentration rose from 3.4 mg/L to 4.3 mg/L, but the maximum decreased from 15.8 mg/L to 13.4 mg/L. Such incremental changes, however, are expected even under natural conditions.

The Barnaby River discharges into the Southwest Miramichi River 16 km below the mouth of the Renous River. Although scanty, the TOC data suggest that this river contributes some organic loading to the Southwest Miramichi River. The median TOC level was 9.5 mg/L, whereas the minimum and maximum values were 8.0 mg/L and 28.2 mg/L, respectively. TOC concentrations that approach 30 mg/L are normally caused by human activities such as sewage disposal. Rogersville, a community of more than 1200 people, is situated near the upper reaches of the Barnaby River and may be the cause of this organic loading.

The Bartibog River discharges into Miramichi Bay below Millbank. Station OONB01B00019 is located on the Bartibog River at the Highway 8 bridge. The river is not influenced by long-term continuous organic inputs, although forestry practices may exert some impact. The median and maximum TOC levels were 5.7 and 13.5 mg/L, which is similar to other stations uninfluenced by human activity.

Sub-basin 01BP is drained by the Little Southwest Miramichi River and its tributaries. Station OONB01BP0001 is located on this river near its mouth. The median, minimum and maximum TOC levels were consistent with the uninhabited nature of the sub-basin.

Although there are several base metal mining operations situated in sub-basin 01BQ, none are expected to affect the overall long-term organic content of the surface waters. However, domestic wastes may adversely affect the water quality in the lower portion of the Northwest Miramichi River. TOC data were available for stations OONB01BQ0056, OONB01BQ0044, OONB01BQ0008, and OONB01BQ0001. From the results it can be seen that the organic content increases in a downstream direction. It would further appear as if the Sevogle River drains organic matter into the Northwest Miramichi River.

(r) Sub-basins 01BL and 01BK

The TOC data available for the Southwest Caraquet River, the Tracadie River, and the Nepisiguit River are inadequate to characterize these rivers. The Tabusintac River, on the other hand, has one station at OONB01BL0004 at which 11 samples were collected between 1970 and 1978. The median TOC level was 8.5 mg/L and the minimum and maximum TOC values were 4.7 and 26.2 mg/L, respectively. Bog waters feed this river and probably account for the elevated values.

(s) Sub-basin 01BJ

TOC data were available from three rivers in sub-basin 01BJ: the Little, the Tetagouche, and the Jacquet rivers (Table 3.24).

Table 3.24. TOC Comparison - Sub-basin 01BJ

Station	TOC (mg/L)			Location
	Med.	Low	High	
OONB01BJ0010	8.0	2.0	14.3	Little River near Bathurst
OONB01BJ0028	4.3	1.3	10.5	Tetagouche River at mouth
OONB01BJ0029	5.0	2.9	8.0	Jacquet River near Durham Centre

Station OONB01BJ0010 is located on the Little River approximately 6.4 km southwest of Bathurst. Mining operations are not expected to affect the TOC content of this river to any significant degree. TOC levels appear to bear this out. The data indicate that water quality, based on TOC concentrations, is good in the Little River.

Station OONB01BJ0028 is located near the mouth of the Tetagouche River. As with the Little River, water quality based on TOC levels is good.

Station OONB01BJ0029 is located about 3.2 km above the mouth of the Jacquet River. The data reflected low TOC concentration, uninfluenced by urban or industrial development.

(t) Sub-basin 01BE

Station OONB01BE0001 is located on the Upsalquitch River at the railroad bridge in Upsalquitch Station. The upper portions of the Upsalquitch River are not influenced by any major human activities. The median TOC level was 2.9 mg/L. Minimum and maximum TOC levels ranged between 0.5 and 13.9 mg/L.

(u) Restigouche River Basin (O1BA and O1BC)

The quality of water in sub-basin O1BA was monitored at station OONB01BA0001 on the Restigouche River above the confluence with the Kedgwick River. St. Quentin, a serviced community of more than 2300 people, is located near Five Fingers Brook, a tributary to the Restigouche River above station OONB01BA0001. The median TOC level was 1.5 mg/L, and the minimum and maximum values were 1.0 and 3.0 mg/L. From the data it would appear that St. Quentin does not adversely affect the water quality of the Restigouche River.

Station OONB01BC0001 is located on the Restigouche River below the Kedgwick River and downstream from station OONB01BA0001. Kedgwick, with a serviced population of more than 1200, is also located upstream from this station. The median TOC level was 3.8 mg/L, and the minimum and maximum values were 0.5 and 7.5 mg/L, indicating a slight impact from the community of Kedgwick.

3.2.2 Mining

3.2.2.1 Base Metal Mining

Base metal mining operations in New Brunswick are located in the highlands and thus in headwater areas. Ores are, for the most part, metallic sulphides, including copper, lead, zinc, antimony, and bismuth sulphides (New Brunswick Department of Natural Resources, 1979, 1981).

The most significant documented impact from base metal mining operations is the phenomenon of acid mine drainage, which results from the oxidation of sulphides to sulphates. Waters receiving acid mine drainage have low pH (2-4) and high acidity and contain high concentrations of such constituents as aluminum, calcium, sulphate, iron, and heavy metals (Conn and Schmidt, 1971; Glover, 1973).

Acid mine drainage impairs receiving waters as a resource for recreation and water supply, as well as destroying the aesthetic quality. Acid mine drainage is also extremely deleterious to most forms of aquatic life. Damages to aquatic life include reduction in faunal populations and replacement of fish species. The deposition of ferric hydroxide or related compounds can smother bottom organisms and reduce the number of adequate spawning areas (Environmental Protection Service, 1979; Glover, 1973).

As of 1980, there were only four producing base metal mines in New Brunswick (New Brunswick Department of Natural Resources, 1981). These are the Brunswick Mining and Smelting Corporation's No. 6 and No. 12 mines, Heath Steele, and Lake George Antimony. However, over the last 20 years or so (period for which water quality data are available), there has been sporadic production in others. Means and ranges of selected parameters for NAQUADAT stations at the mine sites are given in Table 3.25.

3.2.2.2 Producing Mines

(a) Heath Steele Mine

The Heath Steele Mine is located 51 km northeast of Newcastle in the headwaters of the Tomogonops River. The mine began production of copper, lead, zinc, and silver in 1957. It shut down in 1958 and reopened in the early 1960s. The operation consists of sulphide ore extraction and ore concentration using a flotation process. Production rose from 800 t/d, in 1958 to 4000 t/d in 1977.

Table 3.25. Means and Ranges of Selected Parameters Recorded at Mine Sites

Mine	Station No.	pH	Ca	SO ₄	Fe
Brunswick Mining No. 6	00NB01BK0003	3.7 (2.5-8.2)	66.7 (2.5-462)	540 (31-1417)	4.0 (0.1-72)
	00NB01BK0006	4.9 (3.4-11.5)	9.4 (2.7-102)	30.5 (7.7-188)	0.6 (0.1-285)
	00NB01BK0007	6.8 (2.9-7.6)	5.1 (0.9-265)	8.0 (4.2-194)	0.2 (0.03-301)
	00NB01BK0026	6.9 (6.0-8.2)	5.2 (1.3-9.9)	9.7 (2.0-22)	0.2 (0.08-0.7)
	00NB01BK0050	6.5 (6.1-6.7)	11.2 (3.4-35)	40 (7.0-74)	0.4 (0.18-1.5)
Brunswick Mining No. 12	00NB01BJ0009	6.7 (2.3-7.5)	8.8 (2.5-440)	500 (3.4-2520)	0.3 (0.06-18)
	00NB01BJ0010	3.2 (2.5-7.2)	41.7 (5.4-536)	386 (2.0-2123)	7.2 (0.2-88)
Heath Steele	00NB01BQ0013	6.4 (3.3-6.9)	2.2 (1.2-203)	26.3 (5.4-722)	0.5 (0.11-2.9)
	00NB01BQ0017	4.7 (3.2-6.7)	11.2 (1.9-75)	49.6 (4.0-879)	1.1 (0.14-11)
	00NB01BQ0018	7.0 (5.9-7.5)	29.7 (6.0-75)	45.0 (2.0-263)	0.16 (0.01-3.0)
	00NB01BQ0019	7.1 (2.5-7.7)	6.3 (2.5-270)	20.0 (2.0-1797)	0.11 (0.01-1.2)
	00NB01BQ0039	3.3 (2.7-7.3)	24 (6.0-140)	253 (161-1193)	14.5 (0.61-50)
Lake George Antimony	00NB01AK0028	6.7 (6.4-7.4)	9.8 (3.3-18)	7.0 (3-20)	0.2 (0.13-0.26)
	00NB01AK0020	6.7 (6.1-7.4)	5.7 (2.7-17)	6.0 (3-12)	0.19 (0.08-0.54)
Restigouche	00NB01BK0035	6.9 (5.0-7.6)	4.5 (3.1-7.5)	2.0 (12.0-8.0)	0.08 (0.02-0.23)
Wedge Mines	00NB01BK0017	6.9 (4.6-7.6)	4.3 (2.4-7.5)	4.0 (12.0-928)	0.08 (0.03-1.1)
	00NB01BK0032	6.8 (4.4-9.0)	4.5 (2.4-10)	5.0 (2.0-65)	0.11 (0.04-7.5)
Nigadoo River Mine	00NB01BJ0013	7.4 (6.7-8.1)	23 (8.0-70)	19 (5.0-26)	0.11 (0.02-0.68)
Texas Gulf Sulfur	00NB01BK0026	6.9 (6.0-8.2)	5.2 (1.3-9.9)	9.7 (0.2-22)	0.2 (0.08-0.74)
Anaconda American Brass	00NB01BK0012	7.1 (6.0-7.8)	9.5 (3.5-15)	7.0 (2.0-11)	0.11 (0.03-0.33)
	00NB01BK0015	7.1 (6.0-7.7)	8.2 (3.4-14.5)	15.5 (5.0-25)	0.09 (0.02-0.561)
	00NB01BK0020	7.0 (6.0-8.0)	5.7 (2.9-12.7)	8.0 (2.0-17)	0.09 (0.01-0.65)
Mount Pleasant Tin	00NB01AQ0011	6.4 (5.0-7.0)	4.0 (2.1-5.2)	5.0 (2-10)	0.24 (0.12-0.35)
	00NB01AQ0012	6.7 (5.9-7.1)	4.4 (2.9-9.7)	4.5 (4-8)	0.18 (0.09-0.30)
	00NB01AQ0013	6.6 (5.4-7.4)	4.2 (2.0-7.3)	4.5 (2-9)	0.18 (0.10-0.33)
Chester Mines	00NB01BQ0054	6.7 (6.0-7.1)	4.8 (1.8-9.3)	5.6 (3-22)	0.15 (0.01-0.54)
	00NB01BQ0055	6.6 (6.0-7.3)	4.2 (1.5-5.4)	4.0 (2-45)	0.13 (0.02-0.59)
	00NB01BQ0031	6.9 (3.8-7.4)	4.7 (2.3-8.3)	—	0.18 (0.09-0.47)
Burnthill Tungsten	00NB01BM0002	6.7 (5.1-7.2)	4.3 (2.7-6.4)	5.0 (4-14)	0.19 (0.08-0.29)
	00NB01BM0003	6.6 (4.3-7.3)	4.2 (2.6-6.4)	5.0 (3-14)	0.19 (0.07-1.6)

Treatment of the effluent commenced in 1960, when mine water and hydrated lime were mixed together in settling ponds prior to discharge into the Little South Tomogonops River. This treatment system was subsequently expanded into a full-scale pollution abatement effort in the late 1960s.

Data from the stations for Heath Steele in Table 3.25 indicated discharge of both acid mine drainage and treated effluent. Certain stations (OONB01BQ0017 and OONB01BQ0039) downstream from the untreated effluent were characterized by low pH values (2.7), high sulphate (1193 mg/L), and high heavy metals concentrations (e.g., maximum copper was 48 mg/L, zinc 187 mg/L, and iron 50 mg/L). It was evident from the water quality data that the river improved when the untreated effluent was not released; pH values were higher (7.3), and metal concentrations were much lower (iron 0.61 mg/L, copper <0.01, and zinc 0.15 mg/L).

The treated effluent from the tailings pond had high sulphate values peaking at 805 mg/L, with a median of 399 mg/L; pH values that ranged to 10.3, with a median of 7.0; and calcium values as high as 1400 mg/L, with a median of 164 mg/L. Heavy metals levels downstream from the tailings pond outfall were low. Copper and zinc had median values of 0.02 and 0.15 mg/L, respectively, and lows of less than 0.001 and 0.01 mg/L, respectively. Maximum values of 72.5 mg/L for copper and 126 mg/L for zinc were observed.

Water quality monitoring stations upstream from the mining area were unaffected except on one occasion. This occurrence probably reflected short-term exploration activities by the mining operations. Station OONB08BQ0018, located well downstream from the confluence of the South Tomogonops and the Tomogonops rivers, is far enough from the mine that most parameters were comparable to the selected background levels (OONB08BQ0002 and OONB08BQ0045). The slightly elevated medians for calcium and sulphate at OONB08BQ0018 probably reflect the last discernible influences of the upstream mining activities, but these influences are not significant.

(b) Brunswick Mining and Smelting No. 6 Mine

The Brunswick No. 6 mine is located about 29 km southwest of Bathurst in the Nepisiguit watershed. Activities began at this mine in 1953-57 with the construction of an open pit and pilot mill. The mine reached production in 1966.

Sporadic release of acid mine drainage has resulted in variable water quality. At one monitoring station the pH value ranged from 2.5 to 8.2, the copper levels varied from 0.01 to 10 mg/L, and zinc from 0.04 to 125 mg/L. Further downstream, approximately 3 km below the mine site, pH values ranged from 4.4 to 6.7, and zinc levels ranged from 0.6 to 4.7 mg/L. About 1 km farther downstream, the influence was much less apparent with a minimum pH of 6.0 and maximum concentration of copper of 0.16 mg/L and zinc of 1.2 mg/L.

(c) Brunswick Mining and Smelting No. 12

The Brunswick No. 12 mine is located about 25 km southwest of Bathurst. Acid mine drainage was evident 11 km downstream from the mine site (Table 3.25). The wide range of certain parameter values reflect periods of start-up and shut-down in the early 1960s coupled with sporadic operation of the lime treatment system. The treatment system was evidently not operating on July 24, 1975. Approximately 11 km downstream from the mine site (OONB01BJ0010), the pH was 2.9, sulphate 1000 mg/L, and zinc 3.9 mg/L. On September 16, 1975, the pH was 6.3, sulphate 540 mg/L, and zinc 0.4 mg/L. These values suggest that the water was being treated by the lime addition.

(d) Lake George Antimony

The Lake George Antimony mine is about 35 km southwest of Fredericton. Discharges from the settling pond were generally low as most wastewater is recycled. The water quality data indicated no evidence of acid mine drainage. There were, however, slightly elevated antimony values that ranged from 0.002 to 0.03 mg/L, with a median of 0.015 mg/L, at 00NB01AK0020, and from 0.001 to 0.16 mg/L, with a median of 0.019, at 01NB01BJ0019.

3.2.2.3 Coal Mining

Over 50 coal occurrences have been reported in the carboniferous basin in New Brunswick (Inland Waters Directorate, 1979). Commercial production of coal, however, is limited to strip mining of the Grand Lake coal field in the Minto-Chipman area. Potential commercial deposits have been located in the Beersville, Lake Stream, and Dunsinane areas of New Brunswick.

Three potentially significant water quality impacts can be expected from coal strip mining. These are clear-cutting, erosion and siltation, and acid mine drainage. Clear-cutting during site preparation for stripping of overburden, and other clearing, can result in increased nitrification. This results in nitrates and cations (Ca, Mg, Na, K) leaching through the soil material into receiving waters as well as an increase in hydrogen ions. The increase in nutrients can lead to increased primary productivity and thus to eutrophication within receiving waters (Sopper, 1975).

Erosion and siltation resulting from mine site preparation and mine operations can seriously impair the quality of receiving waters. Suspended silt and clay-sized particles can greatly increase turbidity. This impact adversely affects such water contact sports as swimming, and can limit sunlight penetration, which in turn limits photosynthesis and may result in the removal of nutrients from solution by absorption (Inland Waters Directorate, 1979). Impacts of increased turbidity on fish include clogging of gills, destruction of food sources, alteration of numbers and species composition, retardation or elimination of spawning activity, destruction of fish eggs and larvae, alteration of water chemistry, and reduction of visibility, impairing the ability of the fish to catch prey (Ritchie, 1972).

Acid mine drainage, previously described, is also a potential hazard to receiving waters in the area of coal mining. The source of the acid drainage is the metal sulphides, especially pyrite, often associated with coal deposits.

The Environmental Protection Service (1979) reported on the environmental monitoring of coal mining in the Grand Lake coal basin, operated by New Brunswick Coal Limited (Fig. 3.1). Conditions at the strip mines were similar in that erosion rates were high during rainstorms and there was evidence of high turbidity and acid mine drainage in water lying on the site. The only problem with discharge from the Chipman operation was high turbidity, with suspended solids ranging from 36 to 70 000 mg/L. Heavy metals, except for lead at a maximum of 0.3 mg/L, were acceptably low, and pH ranged from 7.6 to 8.0, indicating no acid production.

At one monitoring station, acid drainage was the major problem, with pH ranging from 3.5 to 4.9 and acidity from 22 to 150 mg/L (as CaCO_3). Aluminum ranged from 1 to 18 mg/L and iron from 0.8 to 25 mg/L. Other heavy metals were low. Turbidity, ranging from 32 to 480 mg/L, was much less of a problem than at the Chipman mine.

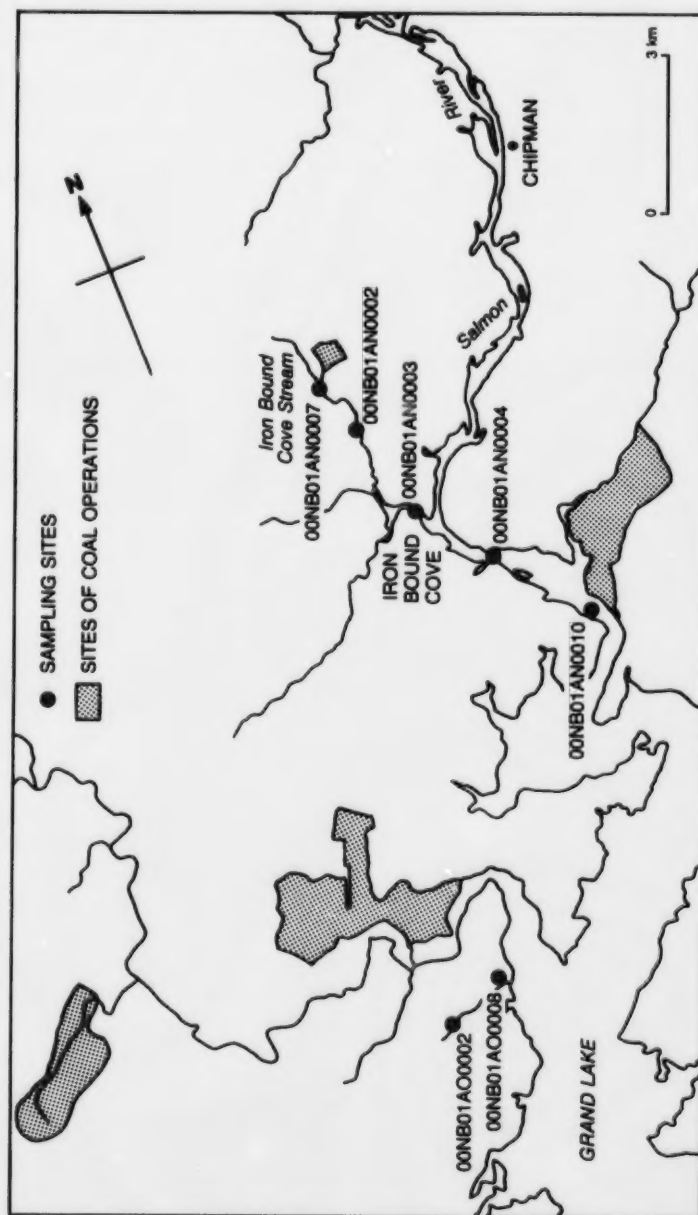


FIGURE 3.1 WATER QUALITY SAMPLING SITES IN THE GRAND LAKE COAL BASIN

Discharge from the coal preparation plant has been described as "environmentally unacceptable" (Environmental Protection Service, 1979, p. 55), with acid drainage and turbidity. Suspended solids at the discharge point ranged from 29 to 3000 mg/L, and pH ranged from 3 to 7. Total dissolved solids varied from 880 to 3000 mg/L, including sulphate ranging from 564 to 1100 mg/L. Maximum iron and aluminum values were 750 and 120 mg/L, respectively, while maximum values for copper, zinc, lead, and cadmium concentrations were 1.6, 1.4, 0.40, and 0.029 mg/L, respectively. Iron Bound Cove Stream has been reported as being without vegetation or aquatic organisms for about 6 km downstream from the coal wash plant (Redmond, 1970).

A one-day survey (July 26, 1977) was undertaken by the Environmental Protection Service to investigate the overall effect of the various coal mining and related activities on the Salmon River (Environmental Protection Service, 1979). No adverse effects were noted, leading to the conclusion that the capacity of the river to assimilate the effluent from the operations was sufficient.

The stations in Iron Bound Cove Stream all displayed evidence of impacts from the coal mining operations. Low pH values, high sulphate, iron, and manganese levels indicated acid mine drainage. High turbidity values resulted from erosion and probably from acid mine drainage. There was an indication of slightly elevated nitrate concentrations. High fluoride levels were also observed. High fluoride concentrations occur under conditions of acid mine drainage. For example, at station OONB01A00003 when fluoride concentration was 10 mg/L, sulphate was 5.5 mg/L and pH was 2.9. The downstream trend showed a marked increase in all parameters (decrease in pH) followed by a general decrease in parameters (increase in pH).

The two stations located on Newcastle Creek may indicate some impact from coal mining in the Minto area. Sulphate levels ranged as high as 83.7 mg/L at OONB01A00002 and 109 mg/L at OONB01A00008, with means for each station of 30 and 48.3 mg/L, respectively. At OONB01A00002, pH ranged from 4.1 to 7.1, with a mean of 6.8, and OONB01A00008 had a mean pH of 5.2, with a range from 4.5 to 6.6. Background means for lowland surface waters were 4.8 mg/L for sulphate concentration and 6.8 for pH. The increase in parameters from OONB01A00002 to OONB01A00008 probably reflects mining operations between the two stations.

In conclusion, effluent from the coal preparation plant has seriously impaired the water quality of Iron Bound Cove Stream and will continue to do so as long as mitigating measures are not introduced into the plant operations. The effect is slight at the mouth of the Salmon River. The operation in the Minto area has a much less significant impact on Newcastle Creek.

3.2.3 Pulp and Paper

The pulp and paper mills in the Atlantic region have shown some improvement in the abatement of pollutants entering receiving waters from their effluent discharges (Fig. 3.2).

Over the past 20 to 30 years, the consumption of water for the production of pulp has fallen to less than 90 000 L of water per tonne of pulp in some modern kraft mills. However, greater amounts of process water are still required in older, less efficient pulp mill operations.

The major pollution characteristics of pulp and paper wastes are suspended solids, soluble organic compounds, aesthetic pollution, pollution toxic to aquatic life, and soluble inorganic compounds. The effluents (non-toxic to humans and containing no pathogenic organisms) are normally diluted by factors of several hundred to several thousand to one.

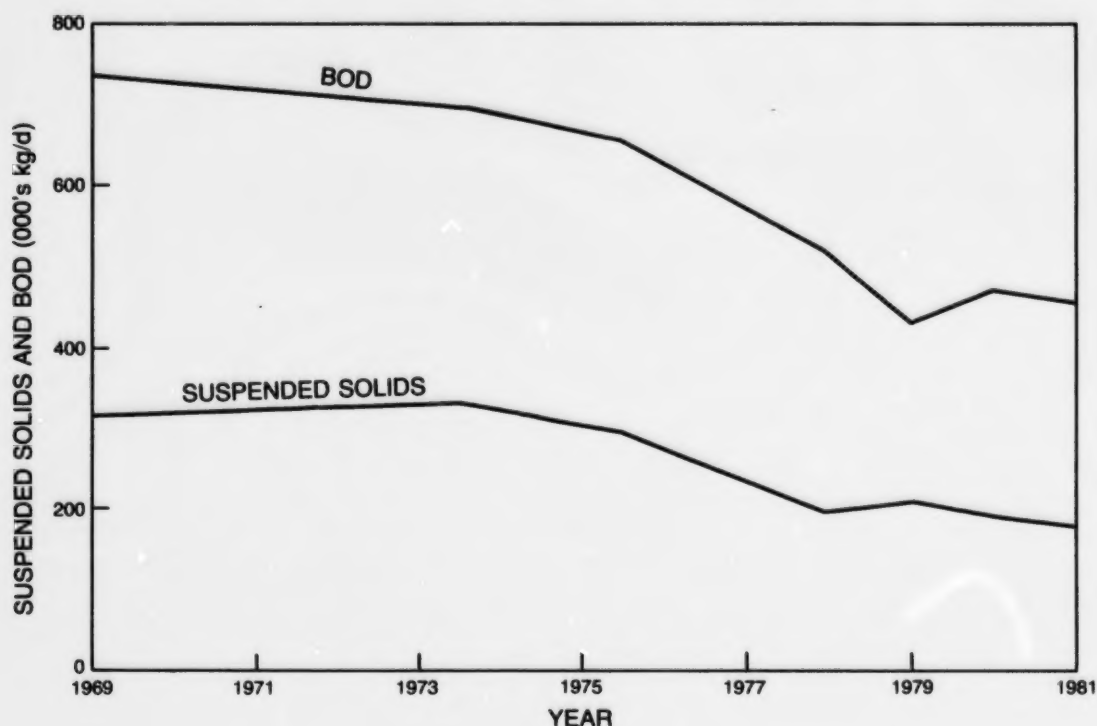


FIGURE 3.2 ATLANTIC REGION PULP AND PAPER EFFLUENT DISCHARGES

Average pulp mill production from New Brunswick mills is 506 t/d per mill, with outputs ranging from a high of 873 t/d to a low of 49 t/d.

Suspended solids include fine bark particles and silt from the woodroom; fiber and fiber particles from both the pulp and papermaking operations; and coating and filling materials such as talc, clays, calcium carbonate, and titanium dioxide from the papermaking process. Seventy-five to ninety percent of the total suspended load settles on the bed of the receiving stream to form sludge deposits. Sludge deposits are unsightly and may become odorous as they decay. The decomposition of submerged sludge deposits exerts a heavy oxygen demand on overlying water contained in shallow, quiescent areas. Anaerobic conditions may therefore result during the hot summer season. Most of the nonsettling portion consists of wood fines, titanium dioxide, clay, and other finely divided filler or coating material. In the area of discharge, sunlight penetration may be reduced due to discoloration of the water, and in only some cases a river's assimilative capacity is sufficient for self-purification.

The desired cellulosic fiber is separated from the nonfibrous material in the pulpwood log. The nonfibrous, soluble part is then discarded as waste material. Up to 50% of the pulpwood log may be composed of sugars, carbohydrates, and related compounds. In small enough quantities, these compounds serve as food for microorganisms. However, excessive amounts result in the rapid growth of waterborne microorganisms.

This condition may lead to a sharp depletion of oxygen that can be hazardous to fish stock and other forms of aquatic life. Anaerobic bacteria may also be activated to produce the unpleasant odours associated with biological decay. The presence of large amounts of organic material can help trigger the growth of bacterial slimes if several other factors, in addition to the availability of food, are included simultaneously.

The types of pollution described above can contribute to aesthetic pollution. Aesthetic pollution is held to a minimum by primary treatment to remove settleable solids, floating solids, scum, and oil slicks. At present, only three types of aesthetic pollution can be only partially taken care of: the dark colour of effluents from the kraft pulping and bleaching process, the generation of foam in some waterways, and the obvious streaks of finely divided clay and titanium dioxide observed in receiving streams.

Resin and fatty acid soaps, by-products collected from the manufacturing of kraft pulp, affect fish by coating the gill filaments. These constituents are controlled by biological treatments normally in the form of aerated lagoons.

Soluble inorganic compounds may be a problem faced by the pulp and paper industry in general. Increased chloride content in receiving waters has been monitored from the viewpoint of possible increases in corrosion experienced by downstream users.

Mills producing bleached kraft pulp include Boise Cascade of Newcastle, Consolidated Bathurst of Bathurst, and Irving Pulp and Paper Co. Ltd. of Saint John. Mills utilizing the sulphite process include New Brunswick International Paper at Dalhousie and Frasers at Atholville and Edmundston. Fraser Inc, at Edmundston also produces groundwood pulp, as do MacMillan Rothesay at Saint John and Acadian Forest Products Ltd. at South Nelson. Neutral sulphite semichemical pulp is produced by Lake Utopia Paper at St. George and by Consolidated Bathurst at Bathurst.

The pulp and paper industry, as seen by its multitude of processes and products, is not a single industry, but rather a number of industries. The procedure used to produce a similar product may vary from one mill to another and the subsequent pollution problems associated with each plant and product will vary accordingly.

CHAPTER FOUR

RIVER BASIN QUALITY

The chemical quality of all surface and ground waters in the following basins were assessed in relation to guidelines for domestic consumption and for the protection of aquatic life. Guidelines used to assess the compliance of water quality data for the above requirements are listed in Tables 4.1 and 4.2. The assessment of the available data base was accomplished using the computerized noncompliance analysis technique described by McNeely and Weimanis (1978).

In this technique, the computer program compares the numeric values of the chemical constituents to the guideline levels described for various water uses and the results are listed in summary tables. Each table (see Table 4.4 for example) lists the number of non-compliant values, the number of values included in the analysis (noncompliant plus compliant), and the number of excluded (results reported as "less than") values. The last column lists the median value of the noncompliant values. The magnitude of the difference between the guideline level and this median value allows an assessment of the degree of severity of noncompliances. It should be noted, however, that not all water quality parameters could be related to specific guidelines since in some cases there were no guidelines available for comparison.

Table 4.1. Guidelines Used in the Noncompliance Analysis of
Water Data - Acceptable Levels for Drinking Water

Parameter	Level ¹	Reference
Arsenic, as A	≤0.05 mg/L	(1)
Barium, as Ba	≤1.0 mg/L	(1)
Boron, as B	≤ 5.0 mg/L	(1)
Cadmium, as Cd	≤0.005 mg/L	(1)
Chloride, as Cl	≤250.0 mg/L	(1)
Colour	≤15 TCU	(1)
Copper, as Cu	≤1.0 mg/L	(1)
Fluoride, as F	≤1.5 mg/L	(1)
Iron, as Fe	≤0.3 mg/L	(1)
Lead, as Pb	≤0.05 mg/L	(1)
Manganese, as Mn	≤0.05 mg/L	(1)
Nitrate & Nitrite, as N	≤10.0 mg/L	(1)
pH	6.5-8.5	(1)
Phosphate, total as P	≤0.100 mg/L	(2)
Phosphorus, as P	≤0.200 mg/L	(2)
Selenium	≤0.01 mg/L	(1)
Sodium, as Na	≤270.0 mg/L	(3)
Sulphate, as SO ₄	≤500 mg/L	(1)
Temperature	≤15°C	(1)
Total dissolved solids	≤500 mg/L	(1)
Turbidity	≤5 NTU	(1)
Zinc, as Zn	≤5.0 mg/L	(1)

(1) Department National Health and Welfare, 1979.

(2) U.S. Environmental Protection Agency, 1976.

(3) Hart, 1974.

Table 4.2. Guidelines Used in the Noncompliance Analysis of Surface-Water Data - Protection of Freshwater Aquatic Life

Parameter	Level ¹	Reference
Cadmium, as Cd	≤0.0002 mg/L	(1)
Chromium, as Cr	≤0.04 mg/L	(1)
Copper, as Cu	≤0.005 mg/L	(2)
Iron, as Fe	≤0.300 mg/L	(2)
Lead, as Pb	≤0.03 mg/L	(3)
Nickel, as Ni	≤0.025 mg/L	(2)
Oxygen (diss.), as O ₂	>4.0 mg/L	(4)
pH	6.5-9.0	(5)
Phosphate (total), as P	≤0.100 mg/L	(6)
Suspended solids	≤25 mg/L	(3)
Zinc, as Zn	≤0.030 mg/L	(2)

(1) Environment Canada, 1979.

(2) Great Lakes Water Quality Board, 1976.

(3) Environmental Studies Board, 1973.

(4) Department of the Environment, 1972.

(5) International Joint Commission, 1977.

(6) U.S. Environmental Protection Agency, 1976.

The discussion herein will only highlight the parameters that are in noncompliance of the stated water quality guidelines. It should be noted that in certain cases the data base compiled over the study period was designed around problem areas related to industrial activity. Therefore these data are considered to be biased due to the designs of past water quality survey and monitoring programs. In other words, in some basins more samples were collected from problem areas than from nonproblem areas.

A temporal factor was also identified with certain water quality data. The noncompliant values were predominantly from the 1960s and early 1970s. Samples collected in the late 1970s had a much higher percentage of compliant values. This corresponded to the various pollution prevention measures instituted especially by the mining companies.

4.1 Miramichi River Basin

4.1.1 Geology and Physiography

The Miramichi River basin contains two distinct physiographic regions: the Miramichi Highlands and the New Brunswick Lowland. The geology of the highlands is complex, featuring rocks of mainly Ordovician and Devonian age. The younger Devonian rocks have intruded the Ordovician, and consist of granites, granodiorites, various other intrusives, and minor volcanics (rhyolite). The Ordovician age rocks include shales, siltstones, sandstones, minor limestone, and various volcanic rocks. Several base metal deposits have been discovered in the highlands, and activities associated with these deposits have impacted heavily on receiving waters.

The New Brunswick Lowland is underlain by sedimentary rocks of the Carboniferous basin, chiefly Pennsylvanian sandstones, siltstones, shales, and conglomerates. Peatlands also occur almost exclusively in the lowlands (sub-basins O1B0, O1BN) with only a few sites appearing in the Miramichi Highlands (sub-basin O1BM).

The uplands in the transition zone between the lowlands and the highlands are underlain variously by Mississippian age limestone, gypsum, shale, and sandstone, and by Silurian age sediments and minor volcanic and intrusive rocks.

4.1.2 Miramichi Sub-basins

Third-order watersheds, O1BM, O1BP, and O1BQ (Fig. 1.3), are all at least 80% within the Miramichi Highland area. O1BM is drained primarily by the headwaters of the Southwest Miramichi River, O1BP by the Little Southwest Miramichi River, and O1BQ by the Northwest Miramichi River. Sub-basin O1BN is drained by the Cains and Southwest Miramichi rivers. Watershed O1B0 is about 80% within the New Brunswick Lowland and 20% within the Miramichi Highlands. The major highland rivers in this watershed are the Renous and Dungarvon. The Southwest Miramichi River drains most of the lowland area of this watershed. The estuary of the Miramichi River basin is also located within O1B0.

4.1.3 Land Use and Economic Activity

The Miramichi River basin (O1BM, O1BN, O1BP, O1BQ) covers roughly 12 300 km². The basin is not densely populated, containing approximately 6% of the provincial population. The main urban areas in this basin are the towns of Chatham and Newcastle, both of which provide municipal sewage treatment. Only two of the six villages in the basin provide central sewage treatment.

Eighty-three percent of the basin land use is productive woodland. The forest cover in the Miramichi River basin is predominantly softwood.

The cutover areas are concentrated around the Juniper region in the southwest, the upper reaches of the Little Southwest Miramichi River, and the Bartibog River headwaters. Small patches of burn are found halfway up the Lower North Branch Little Southwest Miramichi River, as well as around the community of Barnaby River and just north of Douglastown. Significant reforestation has been undertaken in the Cains River area (O1BN), as well as some efforts in the Bartibog River headwaters area.

In the Miramichi River basin, base metal mining is an important activity. This mining is concentrated at three locations (Heath Steele, Texas Gulf, and Chester Mines), all within watershed O1BQ. Recreation and tourism based on Atlantic salmon fishing is also significant here. Agriculture is very limited and is confined mainly to a strip of hay fields along the Southwest Miramichi River. Secondary industry is concentrated in the Chatham-Newcastle area. Specific industries include chemical products in Chatham and Newcastle, pulp and paper in Newcastle and Nelson-Miramichi, a thermal generating station at Chatham, and industrial parks in both Chatham and Newcastle.

4.1.4 Water Quality

The water chemistry data for the 39 surface-water and 20 ground-water sites contained in the data base are summarized in Table 4.3. This table lists the mean values for the more important parameters. This information provides only a gross approximation of the overall quality of the waters in the basin during the study period.

Table 4.3. Data Summary - Miramichi River Basin

Parameter	Surface water*	Ground water*
Alkalinity (total)	12.1	—
Aluminum (diss.)	0.08	—
Bicarbonate	16.4	107.5
Cadmium (diss.)	<0.001	—
Cadmium (ext.)	0.001	0.001
Calcium	5.4	41.8
Chloride	1.5	72.9
Chromium (ext.)	0.001	0.010
Copper (diss.)	0.012	—
Copper (ext.)	0.212	0.033
Iron (diss.)	0.056	0.020
Iron (ext.)	0.414	0.583
Lead (diss.)	0.008	—
Lead (ext.)	0.008	0.052
Magnesium	0.8	8.5
Mercury (ext.)	0.00014	—
Nickel (ext.)	0.042	—
Oxygen (diss.)	10.3	—
Potassium	0.5	2.7
Sodium	1.7	36.6
Sulphate	6.1	20.2
Zinc (diss.)	0.139	—
Zinc (ext.)	1.223	0.007

*mean (mg/L)

The surface waters are primarily calcium carbonate waters with very low solute content. The conditions are typical of geologic bedrock that has low weathering rates similar to those found throughout this basin. All sampling sites exhibited measurable sulphate levels, which probably result from the oxidation of the "sulphide" minerals occurring in scattered locations in the basin.

The ground waters exhibited a much broader range of water types than did the surface waters. Typically, the water types varied from calcium bicarbonate to sodium chloride with much higher solute content indicating both fresh and brackish waters.

4.1.5 Suitability for Domestic Consumption

Both surface water and ground water can be used as drinking water sources. One method of interpreting data in relation to this use is to compare actual observed values with the maximum acceptable levels for drinking water (Table 4.1). Any water supply exceeding the maximum acceptable levels in one or more of the quality characteristics should be assessed as to its suitability and safety for health, aesthetic, and other reasons (Department of National Health and Welfare, 1979).

The noncompliance analysis of the surface-water data (Table 4.4) showed that out of the 18 parameters assessed, 11 were in noncompliance, and some, such as pH, were frequently (27%) noncompliant. The median of noncompliant values for cadmium, iron, and turbidity were only slightly above the guidelines, whereas the median of noncompliant values for

Table 4.4. Noncompliance Analysis of Surface-Water Data in Relation to Maximum Acceptable Levels for Drinking Water - Miramichi River Basin

Parameter	Guidelines ¹	Number of			Median of noncompliant values
		Noncompliant values	Included values	Excluded values	
Barium, as Ba	≤1.0 mg/L	0	17	0	---
Boron, as B	≤5.0 mg/L	0	17	0	---
Cadmium, as Cd	≤0.005 mg/L	10	604	10	0.007
Chloride, as Cl	≤250.0 mg/L	0	799	0	---
Copper, as Cu	≤1.0 mg/L	28	1730	0	10.0
Fluoride, as F	≤1.5 mg/L	0	255	0	---
Iron, as Fe	≤0.3 mg/L	68	309	0	0.53
Lead, as Pb	≤0.05 mg/L	29	1064	0	0.110
Manganese, as Mn	≤0.05 mg/L	28	207	0	0.080
Nitrate & Nitrite, as N	≤10.0 mg/L	0	627	0	---
pH	6.5-8.5	480	1774	0	6.1
Phosphate (total), as P	≤0.100 mg/L	5	140	0	---
Sodium, as Na	≤270.0 mg/L	0	680	0	---
Sulphate, as SO ₄	≤500 mg/L	8	797	0	764
Temperature	≤15°C	606	1955	0	18.8
Total dissolved solids	≤500 mg/L	0	583	0	---
Turbidity	≤5 NTU	78	1582	0	9
Zinc, as Zn	≤5.0 mg/L	52	1722	0	9.8
Total		1392	14862	10	

¹From Table 4.1.

copper, lead, manganese, sulphate, and zinc greatly exceeded the guidelines. These appear to correlate well with the geophysiographic and land use characteristics of the region. For example, the noncompliant values for metals were predominantly from the base metal mining and processing areas and the noncompliant values for colour originated in either mining or peat bog areas.

In the ground-water data set, 10 out of 14 parameters exhibited noncompliance (Table 4.5). Twelve percent of the chloride values had a median of noncompliant values twice as large as the guideline. On the other hand, 3% of the sodium values had a median of noncompliant values 12 times larger than the guideline. This indicates that some of the ground-water wells are probably contaminated by saltwater intrusion. The biggest problem in ground water appears to be manganese, which exhibited 82% noncompliances with a median of non-compliant values six times higher than the guidelines. Other parameters presenting problems included iron and total dissolved solids. Most of these can be correlated with the geology or the peat bogs in the basin.

4.1.6 Suitability for Protection of Freshwater Aquatic Life

The analysis of surface-water data in relation to the guidelines for the protection of freshwater aquatic life (Table 4.6) indicates that a total of 32% of the values were in noncompliance. The major noncompliant parameters were cadmium (100% noncompliance),

Table 4.5. Noncompliance Analysis of Ground-Water Data in Relation to Maximum Acceptable Levels for Drinking Water - Miramichi River Basin

Parameter	Guidelines ¹	Number of			Median of noncompliant values
		Noncompliant values	Included values	Excluded values	
Cadmium, as Cd	≤0.005 mg/L	0	6	0	—
Chloride, as Cl	≤250.0 mg/L	11	92	0	547.0
Copper, as Cu	≤1.0 mg/L	0	11	0	—
Fluoride, as F	≤1.5 mg/L	0	40	0	—
Iron, as Fe	≤0.3 mg/L	24	91	0	2.17
Lead, as Pb	≤0.05 mg/L	1	6	5	0.086
Manganese, as Mn	≤0.05 mg/L	75	91	0	0.310
Nitrate & Nitrite, as N	≤10.0 mg/L	1	56	0	14.
pH	6.5-8.5	3	91	0	5.6
Sodium, as Na	≤270.0 mg/L	3	87	0	3320
Sulphate, as SO ₄	≤500 mg/L	3	55	0	927
Total dissolved solids	≤500 mg/L	7	52	0	1020
Turbidity	≤5 NTU	2	37	0	7
Zinc, as Zn	≤5.0 mg/L	0	11	0	—
Total		130	726	5	

¹From Table 4.1.

Table 4.6. Noncompliance Analysis of Surface-Water Data in Relation to the Guidelines for the Protection of Freshwater Aquatic Life - Miramichi River Basin

Parameter	Guidelines ¹	Number of			Median of noncompliant values
		Noncompliant values	Included values	Excluded values	
Cadmium, as Cd	≤0.0002 mg/L	195	195	419	0.001
Chromium, as Cr	≤0.04 mg/L	0	17	0	—
Copper, as Cu	≤0.005 mg/L	685	1587	143	0.030
Iron (diss.), as Fe	≤0.300 mg/L	2	251	0	0.43
Iron, as Fe	≤0.300 mg/L	68	309	0	0.53
Lead, as Pb	≤0.03 mg/L	42	1055	9	0.079
Nickel, as Ni	≤0.025 mg/L	10	35	0	0.045
Oxygen (diss.), as O ₂	≥4.0 mg/L	0	176	0	—
pH	6.5-9.0	472	1774	0	6.1
Phosphate (total), as P	≤0.100 mg/L	5	140	0	0.290
Zinc, as Zn	≤0.030 mg/L	817	1722	0	0.070
Total		2296	7261	571	

¹From Table 4.2.

extractable iron (22%), nickel (28%), pH (27%), and zinc (47%). Most of these non-compliant values were from the northern part of the basin, which is influenced by mining operations and bedrock geology.

4.2 Restigouche River Basin

4.2.1 Geology and Physiography

The Restigouche River basin (Fig.1.4) spans three physiographic divisions: the Notre Dame Mountains, the Chaleur Uplands, and the Miramichi Highlands. The Notre Dame Mountains consist of bedrock of Devonian age, including sedimentary rocks (sandstone, shale, and limestone) and volcanic rocks.

The Chaleur Uplands is a peneplain varying in elevation from about 150 m up to local ridges of about 600 m. The uplands are underlain in the west by the same Devonian bedrock as the Notre Dame Mountains. Over most of the rest of the uplands, old rocks of Devonian and Silurian age are predominant, and include chiefly calcareous and argillaceous sedimentary rocks with interbedded volcanics. Some Silurian bedrock occurs in the west central and northeastern regions of the uplands. This consists of a variety of sedimentary rocks and their metamorphic equivalents including sandstones, shales, conglomerates, and limestones. Various volcanic and minor intrusive rocks have also been mapped. The extreme northeast of the uplands is geologically more complex, consisting of rocks ranging in age from Silurian to Pennsylvanian. A variety of sedimentary, metamorphic, intrusive, and volcanic rocks are also featured.

The land rises eastward from the Chaleur Uplands into the Miramichi Highlands, where elevations are generally more than 300 m and range up to about 900 m. Bedrock ranges in age from Lower Ordovician to local areas of Mississippian or Pennsylvanian age rocks. The majority of the highlands consist of Ordovician sedimentary and volcanic rocks, and their metamorphic equivalents, intruded by Devonian granites and other igneous rocks. Silurian rocks similar to those of the Chaleur Uplands, Devonian sedimentary rocks, and minor Mississippian or Pennsylvanian volcanics are also found in the highlands. Base metal deposits similar to those in the Miramichi basin occur in the highlands.

4.2.2 Restigouche Sub-basins

The Restigouche River and its various tributaries drain the western and most of the central region of the basin to Chaleur Bay. Third-order watershed 01BB, in the extreme northwest of the basin drains to the Restigouche River via the Kedgwick River. Sub-basin 01BA is drained by the Restigouche River and sub-basin 01BE to the Restigouche River by the Upsalquitch River and its tributaries. Sub-basin 01BJ drains to the Chaleur and Nepisiguit bays via several rivers, chiefly the Little, Middle, Tetagouche, Nigadoo, Jacquet, Benjamin, Charlo, and Eel rivers. Sub-basin 01BK is drained to Nepisiguit Bay by the Nepisiguit River and its tributaries.

4.2.3 Land Use and Economic Activity

The Nepisiguit sub-basin (01BK) is the least populated basin in the province. Except for that portion of the city of Bathurst at the mouth of the Nepisiguit River, this basin is virtually unpopulated.

The Restigouche sub-basins (01BA, 01BB, 01BC, 01BE, 01BJ) contain roughly 13% of the area of the province and 11% of the population. A portion of the city of Bathurst lies in the area as well. Except for the villages of St. Quentin and Kedgwick (01BA, 01BC), virtually all of the population of these sub-basins is concentrated along the coast of watershed

O1BJ from Nepisiguit Bay to the mouth of the Restigouche River at the head of Baie d'Escuminac. Main urban areas in this stretch, in addition to Bathurst, include the city of Campbellton and the town of Dalhousie; the latter provides municipal sewage treatment. Of the 14 villages in the Restigouche sub-basins, in 1980, only 7 provided municipal sewage treatment.

In terms of land use, the Nepisiguit sub-basin is almost wholly (97%) productive woodland, predominantly softwood. The Restigouche sub-basin also consists primarily of productive woodland (85%), the remainder comprising mainly outdoor recreational and improved pasture and forage areas.

Considerable cutting has taken place throughout the central and downstream portions of the Nepisiguit sub-basin. There is a small burn area on the mainstem Nepisiguit River just north of Heath Steele. Concentrated reforestation activity has been undertaken throughout the lower sub-basin, as well as some efforts in the area north of Nepisiguit Lakes.

The Restigouche River sub-basins are basically mixed wood with pockets of softwoods and hardwoods. Cutting activity has been mainly in the softwood area (O1BB) and in the head-water areas of the Upsalquitch, Tetagouche, Jacquet, and Charlo rivers. A stretch of cleared area is found along the coast of watershed O1BJ from the Jacquet River to Bathurst as well as an isolated patch between St. Quentin and Kedgwick (O1BA, O1BC). Some reforestation activity has taken place, mainly in the area of the Charlo River headwaters (O1BJ).

In the Nepisiguit sub-basin (O1BK), industrial activities except for mining and forestry are concentrated at the mouth of the Nepisiguit River around the city of Bathurst. Base metal mining has been carried out at three locations (Wedge, Brunswick No. 6, and Anaconda mines). Bathurst has a pulp and paper mill and two industrial parks.

The Restigouche River sub-basins area depends heavily on forest-based industries centred particularly in the Campbellton-Dalhousie area. The area has a well-reputed sport fishing and wildlife base. Base metal mining has been carried out at five locations (Kennco, Nigadoo, Anaconda Caribou, Restigouche, and Brunswick No. 12). Limited agricultural activity is undertaken, primarily in the St. Quentin area. Coastal fish-processing plants are found along the coast of Chaleur Bay, watershed O1BJ. Virtually all secondary industry is concentrated in this watershed along the coast from Campbellton and Dalhousie down to Bathurst. Specific industries include chemical products at Dalhousie and Belledune, a smelter at Belledune, a pulp and paper mill and a thermal power plant at Dalhousie, and industrial parks in Atholville and Petit Rocher.

4.2.4 Water Quality

The water chemistry data for the 63 surface-water and 7 ground-water sites sampled in this basin have not been averaged due to the wide range of results. It suffices to say that sub-basins O1BA, O1BB, O1BC, and O1BE have similarities in their quality whereas those in sub-basins O1BL and O1BK have different characteristics.

The surface waters of the Restigouche River basin are basically calcium bicarbonate with low total dissolved solids. Waters in the mining areas, however, have elevated sulphate levels, and in some cases these are equivalent to their bicarbonate levels. The ground waters are mainly calcium bicarbonate with low dissolved solids concentrations.

The chemical quality of all surface and ground waters in the Restigouche River basin were assessed in relation to guidelines for domestic consumption and for the protection of

aquatic life. The magnitude of the difference between the prescribed level and the median value of the noncompliances allows an assessment of the degree of severity of noncompliance.

4.2.5 Suitability for Domestic Consumption

The noncompliance analysis of the surface-water data (Table 4.7) showed that out of the 19 parameters assessed 14 were in noncompliance with the overall percentage of noncompliance of 13%. This indicates that many of the surface waters in this basin are not recommended for use as drinking water without treatment. The most frequently noncompliant parameters were extractable iron (33%), manganese (11%), pH (34%), sulphate (15%), and temperature (24%). The median of noncompliant values for chloride, copper, iron, lead, manganese, sodium, sulphate, TDS, and zinc greatly exceeded the stated guidelines. On the other hand, cadmium exceeded the guidelines only slightly. Here again there appears to be a strong correlation with the geology and land use characteristics of the basin; for example, frequent noncompliance of metals and sulphate in the mining (OIBK) and smelting (OIBJ) areas.

Table 4.7. Noncompliance Analysis of Surface-Water Data in Relation to Maximum Acceptable Levels for Drinking Water - Restigouche River Basin

Parameter	Guidelines ¹	Number of			Median of noncompliant values
		Noncompliant values	Included values	Excluded values	
Barium, as Ba	≤1.0 mg/L	0	12	0	—
Boron, as B	≤5.0 mg/L	0	25	0	—
Cadmium, as Cd	≤0.005 mg/L	23	574	67	0.008
Chloride, as Cl	≤250.0 mg/L	32	921	0	1301
Copper, as Cu	≤1.0 mg/L	35	2745	0	5.6
Fluoride, as F	≤1.5 mg/L	0	249	0	—
Iron, as Fe	≤0.3 mg/L	509	1564	0	2.9
Lead, as Pb	≤0.05 mg/L	145	2117	35	0.28
Manganese, as Mn	≤0.05 mg/L	37	334	0	0.64
Nitrate & Nitrite, as N	≤10.0 mg/L	0	556	0	—
pH	6.5-8.5	904	2456	0	4.3
Phosphate (total), as P	≤0.100 mg/L	3	106	0	—
Phosphorus, as P	≤0.2 mg/L	0	12	0	—
Sodium, as Na	≤270.0 mg/L	8	560	0	579
Sulphate, as SO ₄	≤500 mg/L	151	992	0	1015
Temperature	≤15 °C	239	965	0	18.3
Total dissolved solids	≤500 mg/L	3	324	0	1328
Turbidity	≤5 NTU	68	893	0	12
Zinc, as Zn	≤5.0 mg/L	33	877	0	10.0
Total		2190	16282	102	—

¹From Table 4.1.

The ground-water data set was sparse (94 data points) compared to the surface-water data set (16 282 data points). Moreover, the overall frequency of noncompliance (Table 4.8) was relatively low (13%). The biggest problems appear to be with chloride (26% noncompliance) and sodium (20% noncompliance) indicative of saltwater intrusion. Both of these parameters also had a median of noncompliant values that greatly exceeded the guidelines.

Table 4.8. Noncompliance Analysis of Ground-Water Data in Relation to Maximum Acceptable Levels for Drinking Water - Restigouche River Basin

Parameter	Guidelines ¹	Number of			Median of noncompliant values
		Noncompliant values	Included values	Excluded values	
Chloride, as Cl	<250.0 mg/L	4	15	0	1200
Iron, as Fe	<0.3 mg/L	0	13	0	—
Manganese, as Mn	<0.05 mg/L	3	14	0	0.3
Nitrate & Nitrite, as N	<10.0 mg/L	0	12	0	0.3
pH	6.5-8.5	2	13	0	6.3
Sodium, as Na	<270.0 mg/L	3	15	0	600
Sulphate, as SO ₄	<500 mg/L	0	12	0	—
Total		12	94	0	—

¹From Table 4.1.

4.2.6 Suitability for Protection of Freshwater Aquatic Life

An analysis of surface-water data in relation to the guidelines for the protection of freshwater aquatic life indicated that a total of 38% of the values were in noncompliance (Table 4.9). The major noncompliant parameters were cadmium (25%), copper (68%), iron (30%), pH (26%), and zinc (74%). Here again the noncompliant parameters are usually associated with sampling sites in the mining or smelting areas. It should be noted, however, that these data are somewhat biased since sampling was conducted predominantly in the mining areas because of the existing pollution or threat of pollution by the mining activity. In other words, more samples were collected from problem areas than from non-problem areas. On close inspection of the temporal variability, it could easily be seen that the quality of the water improved over the years, especially in the OIBJ and OIBK sub-basins. This corresponds to the various pollution prevention measures instituted by the mining industries.

4.3 Upper Saint John River Basin

4.3.1 Geology and Physiography

The upper Saint John River basin (Fig. 1.5) features three physiographic regions: the Notre Dame Mountains, the Chaleur and New England uplands, and the Miramichi Highlands. The Notre Dame Mountains are found in the northern extremity of the basin, and consist of bedrock, including sedimentary rocks (sandstone, shale, and limestone) and volcanic rocks. Most of the basin is situated in the Chaleur and New England uplands. The Chaleur Uplands are underlain partially by the same rocks that form the Notre Dame Mountains. Much of the

Table 4.9. Noncompliance Analysis of Surface-Water Data in Relation to the Guidelines for the Protection of Freshwater Aquatic Life - Restigouche River Basin

Parameter	Guidelines ¹	Number of			Median of noncompliant values
		Noncompliant values	Included values	Excluded values	
Cadmium, as Cd	<0.0002 mg/L	163	641	0	—
Chromium, as Cr	<0.04 mg/L	0	25	0	—
Copper, as Cu	<0.005 mg/L	1376	2035	295	0.3
Iron, as Fe	<0.300 mg/L	548	1855	0	4.2
Lead, as Pb	<0.03 mg/L	167	1674	44	0.15
Nickel, as Ni	<0.025 mg/L	6	119	0	0.03
Oxygen (diss.), as O ₂	>4.0 mg/L	4	432	0	3.7
pH	6.5-9.0	683	2656	0	4.2
Phosphate (total), as P	<0.100 mg/L	3	106	0	0.130
Suspended solids	<25.0 mg/L	11	29	0	38
Zinc	<0.030 mg/L	1618	2187	0	0.24
Total		4579	11759	339	

¹From Table 4.2.

eastern half of the Chaleur Uplands is underlain by calcareous and argillaceous sedimentary rocks with interbedded volcanics. Similar rocks underlie much of the New England Uplands.

The majority of the Miramichi Highlands consists of sedimentary and volcanic rocks and their metamorphic equivalents intruded by Devonian granites and other igneous rocks.

4.3.2 Upper Saint John River Sub-basins

The upper Saint John River basin is drained by the Saint John River and its tributaries. The St. Francis and the Madawaska rivers and various smaller streams drain the third-order watershed OIAD from the north to the Saint John River. Sub-basin OIAF drains from the north via the Green, Quisibis, Siegas, Grand, Little, and Salmon rivers and several smaller streams. Watershed OIAH is drained from the northwest by the Tobique River and its tributaries. The Aroostook and Limestone rivers, which originate in Maine, drain sub-basin OIAD to the Saint John River.

4.3.3 Land Use and Economic Activity

The upper Saint John River basin (OIAD, OIAF, OIAG, OIAH) contains 8.5% of the provincial population. Much of the area of this basin, particularly watershed OIAH and much of OIAF, is virtually unpopulated except for along the river. The major urban areas here are the city of Edmundston and the towns of Grand Falls and St. Leonard. The latter two provide municipal sewage treatment. Of the 15 villages in the upper basin, 8 provide central sewage treatment.

Eighty-three percent of the upper Saint John River basin is productive woodland. The highest concentration of agricultural land in the province is found in this basin. The remaining land use consists of outdoor recreational and improved pasture and forage areas.

The basin has a good distribution of softwood, hardwood, and mixed woods. Hardwoods are found primarily in watersheds OIAD and OIAF above Green River and in a stretch between the Salmon and Tobique rivers in OIAH. A large tract of mixed wood is found in the Green-Quisibis-Siegas rivers area, and softwoods are found primarily to the south of the Tobique River in OIAH. Limited cutting activity has taken place in isolated tracts in the northern and eastern portions of the basin. There are cleared areas along the main stem of the Saint John River from Clair, south to below Grand Falls and along the lower Tobique River. Concentrated reforestation efforts have been undertaken in the First Lake-Green River headwaters area of watershed OIAF, as well as other isolated efforts.

In addition to forestry operations, agriculture and associated food processing are important activities in the basin. Water-based recreation potential is high, notably for canoeing and fishing. Specific industrial activities in the basin include food processing and associated facilities at Grand Falls, St. François-de-Madawaska, and Drummond; a pulp mill at Edmundston; and industrial parks at Clair, Grand Falls, and St. Leonard.

4.3.4 Water Quality

The calculated mean values of the water chemistry data collected from the 34 surface-water and 6 ground-water sites in this basin are summarized in Table 4.10. It should be noted that the range for most parameters is quite broad.

Table 4.10. Data Summary - Upper Saint John River Basin

Parameter	Surface water*	Ground water*
Alkalinity (total)	52.4	--
Aluminum (diss.)	0.279	--
Bicarbonate	60.5	177.4
Cadmium (ext.)	0.0012	--
Calcium	21.0	45.3
Chloride	3.3	31.4
Chromium (ext.)	0.0026	--
Copper (ext.)	0.0070	0.0370
Iron (diss.)	0.0326	0.0900
Iron (ext.)	0.2030	0.2506
Lead (ext.)	0.0037	0.0030
Magnesium	2.2	6.8
Nickel (ext.)	0.0149	--
Oxygen (diss.)	9.8	--
pH	7.1†	7.6†
Potassium	0.7	1.3
Sodium	2.1	31.3
Sulphate	10.1	17.0
Total dissolved solids	100.1	310.5
Zinc (ext.)	0.0108	--

*Mean (mg/L).

†Median in pH units.

The surface waters in the upper Saint John River basin are of calcium bicarbonate type with moderate dissolved solids concentrations. The ground waters, on the other hand, are somewhat more variable in chemical composition although basically calcium bicarbonate type. In general, the total dissolved solids concentrations for the ground waters analyzed are higher than most of the surface waters.

4.3.5 Suitability for Domestic Consumption

The noncompliance analysis of the surface water data showed that out of the 16 parameters analyzed, 7 were in noncompliance (Table 4.11). This indicates that many of the surface waters in this basin are not recommended for use as drinking water without treatment. The most frequently noncompliant parameters were iron (21%), manganese (14%), and turbidity (12%). The magnitude of the difference between the prescribed level and the median noncompliant values was greatest for lead and manganese. These two parameters could therefore be said to be the most troublesome parameters in the basin. Lead and manganese levels, which are noncompliant throughout the four sub-basins, are probably due to the geology of the area.

The ground-water noncompliance analysis (Table 4.12) indicated that only three of the ten parameters analyzed exhibited noncompliance. The noncompliant parameters were manganese (16%), nitrate and nitrite (11%), and turbidity (25%). A few wells had very hard water with high manganese concentrations, and two wells were contaminated with nitrate and nitrite. In general, however, the quality of the ground waters is very good and quite suitable for use as drinking water supplies.

Table 4.11. Noncompliance Analysis of Surface-Water Data in Relation to Maximum Acceptable Levels for Drinking Water - Upper Saint John River Basin

Parameter	Guidelines ¹	Noncompliant values	Number of		Median of noncompliant values
			Included values	Excluded values	
Barium, as Ba	≤1.0 mg/L	0	16	0	—
Boron, as B	≤5.0 mg/L	0	22	0	—
Cadmium, as Cd	≤0.005 mg/L	1	859	18	0.006
Chloride, as Cl	≤250.0 mg/L	0	1212	0	—
Copper, as Cu	≤1.0 mg/L	0	826	0	—
Fluoride, as F	≤1.5 mg/L	1	378	0	1.60
Iron, as Fe	≤0.3 mg/L	110	522	0	0.46
Lead, as Pb	≤0.05 mg/L	1	702	4	0.250
Manganese, as Mn	≤0.05 mg/L	100	726	0	0.092
Nitrate & Nitrite, as N	≤10.0 mg/L	0	1524	0	—
pH	6.5-8.5	69	7406	0	6.3
Sodium, as Na	≤270 mg/L	0	1221	0	—
Sulphate, as SO ₄	≤500 mg/L	0	1258	0	—
Total dissolved solids	≤500 mg/L	0	1128	0	—
Turbidity	≤5 NTU	157	1335	0	10
Zinc, as Zn	≤5.0 mg/L	0	759	0	—
Total		439	19894	22	

¹From Table 4.1.

Table 4.12. Noncompliance Analysis of Ground-Water Data in Relation to Maximum Acceptable Levels for Drinking Water - Upper Saint John River Basin

Parameter	Guidelines ¹	Number of			Median of noncompliant values
		Noncompliant values	Included values	Excluded values	
Cadmium, as Cd	≤0.005 mg/L	0	2	0	—
Chloride, as Cl	≤250.0 mg/L	0	13	0	—
Fluoride, as F	≤1.5 mg/L	0	11	0	—
Lead, as Pb	≤0.05 mg/L	0	2	0	—
Manganese, as Mn	≤0.05 mg/L	3	19	0	0.153
Nitrate & Nitrite, as N	≤10.0 mg/L	2	18	0	214
pH	6.5-8.5	0	18	0	—
Sodium, as Na	≤270 mg/L	0	12	0	—
Sulphate, as SO ₄	≤500 mg/L	0	17	0	—
Turbidity	≤5 NTU	3	12	0	13.0
Total		8	124	0	

¹From Table 4.1.

4.3.6 Suitability for Protection of Freshwater Aquatic Life

The analysis of surface-water data in relation to the guidelines for the protection of freshwater aquatic life indicated that a total of 10% of the values were in noncompliance with only 2 of the 11 parameters in constant compliance (Table 4.13). The more frequent noncompliant parameters were cadmium (100%), copper (16%), iron (21%), nickel (37%), and phosphate (13%). The high metal concentrations can be associated with the geology, and the phosphate can be associated with the agricultural land use in the basin. It should be noted that the cadmium values may be somewhat deceiving since the guideline is in the same range as the detection limit, thereby creating a high degree of uncertainty in many of the measured values.

4.4 Middle Saint John River Basin

4.4.1 Geology and Physiography

The middle Saint John River basin (Fig. 1.6) lies within the New Brunswick Highlands in the west and the Chaleur Uplands in the east, and approaches the New Brunswick Lowlands (Gulf of St. Lawrence Plain) in the eastern tip of the basin.

Swampy plains and lakes are common. Geologically the Chaleur Uplands are similar to the highlands in the basin. To the extreme east of the basin a small area of the St. Lawrence Plain varies in elevation from about 130 to about 185 m. The area is underlain by Pennsylvanian age sandstones, shales, siltstones, and conglomerates.

Table 4.13. Noncompliance Analysis of Surface-Water Data in Relation to the Guidelines for the Protection of Freshwater Aquatic Life - Upper Saint John River Basin

Parameter	Guidelines ¹	Number of			Median of noncompliant values
		Noncompliant values	Included values	Excluded values	
Cadmium, as Cd	≤0.0002 mg/L	124	124	753	0.001
Chromium, as Cr	≤0.04 mg/L	0	2	0	—
Copper, as Cu	≤0.005 mg/L	129	807	16	0.020
Iron (diss.), as Fe	≤0.300 mg/L	0	229	0	—
Iron, as Fe	≤0.300 mg/L	110	522	0	0.442
Lead, as Pb	≤0.03 mg/L	1	702	4	0.250
Nickel, as Ni	≤0.025 mg/L	11	30	0	0.030
Oxygen (diss.), as O ₂	≥4.0 mg/L	54	1365	0	2.2
pH	6.5-9.0	66	1406	0	6.0
Phosphate (total), as P	≤0.100 mg/L	136	1025	0	0.147
Zinc	≤0.030 mg/L	68	756	3	0.051
Total		699	6968	776	

¹From Table 4.2.

4.4.2 Middle Saint John River Sub-basins

The basin drains to the south via the Saint John River and its various tributaries. Watershed 01AJ is drained to the Saint John River from the west, chiefly by the Meduxnekeag River and Big Presque Isle Stream, and from the east via the Monquart and Skikatchawk rivers and Cold Stream. Sub-basin 01AL drains to the Saint John River via the Nashwaak River and its tributaries. The Shogomoc and Pokiok rivers drain watershed 01AK from the south of the Saint John River and the Mackawic, Magtaguac, and Keswick rivers and Nashwaaksis Stream from the north.

4.4.3 Land Use and Economic Activity

The middle Saint John River basin (01AJ, 01AK, 01AL) is one of the more densely populated basins in the province, with 13.4% of the population. The population is concentrated along the mainstream and its tributaries, notably the Nashwaak River (01AL) and the Keswick River (01AK). Some of the city of Fredericton and its upstream outskirts are in this basin. Other urban areas include the towns of Hartland and Woodstock (01AJ) and the town of Mackawic (01AK), all of which provide municipal sewage treatment. Of the eight villages in the middle Saint John River basin, only one provides central treatment.

Around 75% of the basin is productive woodland. The remainder consists of improved pasture and forage area, agricultural land, and scatterings of rough grazing and rangeland, outdoor recreational areas, nonproductive woodland, swamps, and marshes.

The middle Saint John River basin is predominantly mixed wood with scatterings of hardwood and softwood. There are considerable cleared areas along the Saint John River and the confluence with its tributaries, and particularly the area west of the river in

watershed 01AJ from Upper Kent, south to below Woodstock. Scattered reforestation efforts have been undertaken in the basin, noticeably in the Nashwaak River headwaters area of watershed 01AL.

Agriculture, forestry, and associated secondary manufacturing are important industrial activities in the middle Saint John River basin. In fact, a sizeable strip on both sides of the Saint John River from Perth-Andover to Hartland is commonly referred to as the New Brunswick potato belt. There is a significant base metal mining undertaking at Consolidated Denham Mines - Lake George (notably antimony), as well as other smaller active developments in the Pokiok, Shogomoc, and Eel river systems. Water-based recreation is an important activity throughout the basin. Specific industrial activities include food processing at Florenceville and Hartland, pulp and paper at Nackawic, chemical products at Jacksonville, textiles at Marysville, and industrial parks at Hartland, Woodstock, and Nackawic.

4.4.4 Water Quality

The calculated mean values of the water chemistry data collected from the 44 surface-water and 39 ground-water sites contained in the data base are summarized in Table 4.14.

Table 4.14. Data Summary - Middle Saint John River Basin

Parameter	Surface water*	Ground water*
Alkalinity (total)	55.9	—
Aluminum (diss.)	0.07	—
Bicarbonate	49.8	111.0
Cadmium (ext.)	0.0016	0.0055
Calcium	17.4	29.6
Chloride	3.7	36.0
Chromium (ext.)	0.0013	—
Copper (ext.)	0.0080	0.0194
Iron (diss.)	0.0329	0.0167
Iron (ext.)	0.1775	1.4698
Lead (ext.)	0.0088	0.1588
Magnesium	1.8	3.8
Nickel (ext.)	0.0160	—
Oxygen (diss.)	10.1	—
pH	7.1†	7.8†
Potassium	0.7	2.3
Sodium	2.5	35.0
Sulphate	9.2	20.4
Total dissolved solids	85.5	239.5
Zinc (ext.)	0.0159	0.0528

*Mean (mg/L).

†Median in pH units.

The majority of the surface waters in the middle Saint John River basin are calcium bicarbonate with variable levels of sulphate and a mean total dissolved solids value of 85.5 mg/L. The ground waters are also predominantly calcium bicarbonate with a much higher mean total dissolved solids value (239.5 mg/L).

4.4.5 Suitability for Domestic Consumption

The noncompliance analysis of the surface-water data showed that out of the 16 parameters analyzed, 4 were in noncompliance part of the time (Table 4.15). In terms of values, only 225 out of 11 818 values or 1.9% of the total were in noncompliance. The more frequent noncompliant parameters were manganese (16%) and pH (30%). In general, the quality is similar to the upper Saint John River basin, but with fewer noncompliances. The non-compliant parameters are attributed to the geology and the agricultural activities within the basin.

Table 4.15. Noncompliance Analysis of Surface-Water Data in Relation to Maximum Acceptable Levels for Drinking Water - Middle Saint John River Basin

Parameter	Guidelines ¹	Number of			Median of noncompliant values
		Noncompliant values	Included values	Excluded values	
Arsenic, as As	≤ 5 mg/L	0	6	1	—
Barium, as Ba	≤ 1.0 mg/L	0	11	0	—
Boron, as B	≤ 5.0 mg/L	0	11	0	—
Cadmium, as Cd	≤ 0.005 mg/L	0	735	45	—
Chloride, as Cl	≤ 250.0 mg/L	0	1587	0	—
Copper, as Cu	≤ 1.0 mg/L	0	634	0	—
Fluoride, as F	≤ 1.5 mg/L	0	525	0	—
Iron (diss.), as Fe	≤ 0.3 mg/L	1	345	0	0.775
Lead, as Pb	≤ 0.05 mg/L	1	535	34	0.060
Manganese, as Mn	≤ 0.05 mg/L	102	628	0	0.099
Nitrate & Nitrite, as N	≤ 10.0 mg/L	0	1209	0	—
pH	6.5-8.5	121	409	0	6.1, 9.2
Sodium, as Na	≤ 270 mg/L	0	1559	0	—
Sulphate, as SO ₄	≤ 500 mg/L	0	1549	0	—
Total dissolved solids	≤ 500 mg/L	0	1479	0	—
Zinc, as Zn	≤ 5.0 mg/L	0	596	0	—
Total		225	11818	80	

¹From Table 4.1.

The ground-water noncompliance analysis indicated that 6 of the 12 parameters analyzed exhibited noncompliances (Table 4.16). The more frequent noncompliant parameters were chloride (19%), manganese (55%), and turbidity (27%). In general, the quality of approximately 90% of the water analyzed is suitable for use as raw drinking water supplies.

4.4.6 Suitability for Protection of Freshwater Aquatic Life

The analysis of surface-water data in relation to the guidelines for the protection of freshwater aquatic life indicated that a total of 12% of the values were in noncompliance with only one of the nine parameters in constant compliance (Table 4.17). The more frequent noncompliant parameters were copper (24%), dissolved oxygen (10%), pH (22%), phosphate (15%), and zinc (12%). As with the upper Saint John River basin, the high metal

concentrations can be attributed to the geology, and the elevated phosphate probably results from agricultural practices. The low dissolved oxygen, however, can only be attributed to the food-processing activities in the basin.

Table 4.16. Noncompliance Analysis of Ground-Water Data in Relation to Maximum Acceptable Levels for Drinking Water - Middle Saint John River Basin

Parameter	Guidelines ¹	Number of			Median of noncompliant values
		Noncompliant values	Included values	Excluded values	
Cadmium, as Cd	<0.005 mg/L	0	4	3	—
Chloride, as Cl	<250.0 mg/L	8	42	0	380
Copper, as Cu	<1.0 mg/L	0	14	0	—
Fluoride, as F	<1.5 mg/L	0	31	0	—
Lead, as Pb	<0.05 mg/L	2	9	5	0.820
Manganese, as Mn	<0.05 mg/L	21	38	0	0.200
Nitrate & Nitrite, as N	<10.0 mg/L	0	24	0	—
Sodium, as Na	<270.0 mg/L	2	44	0	440
Sulphate, as SO ₄	<500 mg/L	0	44	0	—
Total dissolved solids	<500 mg/L	8	37	0	717
Turbidity	<5 NTU	3	11	0	120
Zinc, as Zn	<5.0 mg/L	0	14	0	0
Total		44	312	8	

¹From Table 4.1

Table 4.17. Noncompliance Analysis of Surface-Water Data in Relation to the Guidelines for the Protection of Freshwater Aquatic Life - Middle Saint John River Basin

Parameter	Guidelines ¹	Number of			Median of noncompliant values
		Noncompliant values	Included values	Excluded values	
Chromium, as Cr	<0.04 mg/L	0	109	0	—
Copper, as Cu	<0.005 mg/L	145	605	29	0.020
Iron, as Fe	<0.300 mg/L	2	345	0	0.78
Lead, as Pb	<0.03 mg/L	2	535	34	0.054
Nickel, as Ni	<0.025 mg/L	1	12	0	0.030
Oxygen (diss.), as O ₂	≥4.0 mg/L	153	1526	0	2.2
pH	6.5-9.0	91	409	0	6.0
Phosphate (total), as P	<0.100 mg/L	219	1464	0	0.22
Zinc, as Zn	<0.03 mg/L	69	596	0	0.05
TOTAL		682	5601	63	

¹From Table 4.2.

4.5 Lower Saint John River Basin

4.5.1 Geology and Physiography

A major portion of the lower Saint John River basin (Fig. 1.7) is within the New Brunswick Lowlands. Predominant rock types in this basin include sandstones, shales, siltstones, and conglomerates of Pennsylvanian age, with locally important coal deposits in the Grand Lake area.

West of Grand Lake, the basin rises into upland areas. The upland is underlain largely by Pennsylvanian sediments with Mississippian siltstones, conglomerates, evaporites, volcanics, and intrusive rocks along the western fringe of the basin.

A small area to the extreme southeast of basin O1AP lies within the Caledonian Highlands. The bedrock geology is complex, containing rocks varying from the very old Precambrian age to those of the much younger Pennsylvanian age. Rock types are variable and include sedimentary and metamorphosed sedimentary rocks (such as sandstones, shales, and conglomerates) and volcanic rocks, intrusives, and their metamorphic equivalents.

4.5.2 Lower Saint John River Sub-basins

The lower Saint John River basin is drained to the Bay of Fundy via the Saint John River and its tributaries. Major tributaries include, from the west, the Oromocto and Nerepis rivers and Otnabog Stream. The Salmon River-Newcastle Creek-Little River-Grand Lake system drains sub-basins O1AN and O1AD from the north. Watershed O1AP drains from the east to the Saint John River via the Canaan River-Washadamoak Lake system, Belleisle Bay and its tributaries, and the Kennebecasis River.

4.5.3 Land Use and Economic Activity

The lower Saint John River basin (O1AM, O1AN, O1AO, O1AP), covering a significant portion of the south-central part of the province, is the most heavily populated basin, with 24.4% of the total provincial population. The concentration of the population is noticeably at and around the city of Saint John, at the mouth of the Saint John River, as well as along the Kennebecasis River. Much of the city of Fredericton and its downstream outskirts are in this basin; both cities provide municipal sewage treatment. Other urban centres include the towns of Rothesay and Sussex (O1AP), Oromocto (O1AM, O1AO), and the villages of Chipman and Minto to the north of Grand Lake, all of which provide municipal sewage treatment. Of the 17 villages in the lower basin, 12 provide central sewage treatment.

Roughly 63% of the basin is productive woodland. The basin contains the highest concentration of built-up area in the province. The remaining area consists of improved pasture and forage, nonproductive woodlands, outdoor recreational area, rough grazing and rangeland, swamp, and marsh, notably peatlands in the Oromocto River area of watershed O1AM.

The lower Saint John River basin is predominantly mixed wood. Cutting activity has taken place mainly in the softwood tracts of the Canaan River area (O1AP). There are considerable stretches of cleared area along the Kennebecasis River and its tributaries in the vicinity of Sussex in watershed O1AP. There is a large burn area around Lake Stream in O1AN and smaller burns in the vicinity of Bantalor (O1AN) and west of Minto in O1AO. Concentrated reforestation has been undertaken in the Hardwood Ridge-Newcastle Creek area along the northwest shore of Grand Lake in watershed O1AO, as well as isolated other efforts.

Agriculture, mining and manufacturing are all important activities in the lower Saint John River basin. The main agricultural areas are within the Kennebecasis River Basin and the Maugerville-Sheffield-Jemseg areas. Manufacturing is centred in the Saint John and Sussex area. The Nerepis, Hammond, Kennebecasis, and Oromocto river systems and the Grand and Washademoak lake areas support water-based recreation activities. Specific industrial activities include coal mining at Salmon Harbour-Midland and Newcastle Creek, an associated coal wash plant near Minto, limestone in the Havelock area, potash exploration and development east of Sussex, a coal-fired thermal station at Newcastle Creek, chemical products (e.g., fertilizers) at Havelock and Brookville, petroleum refining and pulp and paper in Saint John, and industrial parks in Fredericton, East Oromocto, Minto, Sussex, Spruce Lake, Grandview, and Saint John.

4.5.4 Water Quality

Table 4.18 lists the calculated mean values for selected parameters of the 84 surface-water and 35 ground-water sites assessed in this basin. The surface waters in the lower Saint John River basin are quite variable, ranging from calcium bicarbonate type, upstream, to sodium chloride type, downstream, with low to moderate dissolved solids. The ground waters are similar in water type, but have higher mineral content (mean TDS value is 383 mg/L) and alkalinity.

Table 4.18. Data Summary - Lower Saint John River Basin

Parameter	Surface water*	Ground water*
Alkalinity (total)	17.0	144.2
Aluminum (diss.)	0.0161	—
Bicarbonate	18.1	147.5
Cadmium (ext.)	0.005	0.001
Calcium	8.1	25.0
Chloride	5.9	65.8
Chromium (ext.)	0.0014	—
Copper (ext.)	0.020	0.045
Iron (ext.)	4.02	2.79
Lead (ext.)	0.017	0.140
Magnesium	1.3	3.0
Nickel (ext.)	0.014	—
Oxygen (diss.)	10.4	—
pH	6.2†	7.5†
Potassium	0.6	3.9
Sodium	4.3	80.1
Sulphate	10.8	37.4
Total dissolved solids	49.1	382.7
Zinc (ext.)	0.073	0.182

*Mean (mg/L).

†Median in pH units.

4.5.5 Suitability for Domestic Consumption

The noncompliance analysis of the surface water data showed that out of the 18 parameters analyzed, 12 were in noncompliance at least once (Table 4.19). In total there were 573 noncompliant values or approximately 7.2% noncompliance. The most frequent noncompliant parameters were manganese (38%) and pH (33%). The magnitude of the difference between the prescribed level and the median noncompliant values was greatest for cadmium, chloride, fluoride, manganese, sodium, sulphate, and turbidity.

Table 4.19. Noncompliance Analysis of Surface-Water Data in Relation to Maximum Acceptable Levels for Drinking Water - Lower Saint John River Basin

Parameter	Guidelines ¹	Number of			Median of noncompliant values
		Noncompliant values	Included values	Excluded values	
Arsenic, as As	<0.05 mg/L	0	13	2	—
Barium, as Ba	<1.0 mg/L	0	10	0	—
Boron, as B	<5.0 mg/L	0	9	0	—
Cadmium, as Cd	<0.005 mg/L	19	320	50	0.040
Chloride, as Cl	<250.0 mg/L	14	945	0	775
Copper, as Cu	<1.0 mg/L	1	383	0	1.1
Fluoride, as F	<1.5 mg/L	2	347	0	7.0
Iron, as Fe	<0.3 mg/L	191	434	0	0.6
Lead, as Pb	<0.05 mg/L	2	307	34	0.085
Manganese, as Mn	<0.05 mg/L	143	378	0	0.153
Nitrate & Nitrite, as N	<10.0 mg/L	0	707	0	—
pH	6.5-8.5	105	318	0	5.9, 8.7
Phosphorus, as P	<0.2 mg/L	0	24	0	—
Sodium, as Na	<270.0 mg/L	12	923	0	512
Sulphate, as SO ₄	<500 mg/L	3	893	0	1280
Total dissolved solids	<500 mg/L	1	688	0	2007
Turbidity	<5 NTU	80	856	0	13.8
Zinc, as Zn	<5.0 mg/L	0	375	0	—
Total		573	7930	86	—

¹From Table 4.1.

The ground-water noncompliance analysis indicated that 9 of the 13 parameters scrutinized, exhibited noncompliances at least once (Table 4.20). In terms of data points, 124 out of 550, or 23%, were noncompliant. The more frequent noncompliant parameters were chloride (20%), iron (60%), lead (40%), manganese (65%), sodium (11%), TDS (28%), and turbidity (27%). Median noncompliant values, which were at least twice the prescribed level, were found for chloride, fluoride, iron, manganese, TDS, and turbidity. Again, as in the rest of the Saint John River basin, iron and manganese are the biggest problems in respect to drinking water supplies.

Table 4.20. Noncompliance Analysis of Ground-Water Data in Relation to Maximum Acceptable Levels for Drinking Water - Lower Saint John River Basin

Parameter	Guidelines ¹	Number of			Median of noncompliant values
		Noncompliant values	Included values	Excluded values	
Cadmium, as Cd	<0.005 mg/L	0	2	0	—
Chloride, as Cl	<250.0 mg/L	13	66	0	524
Copper, as Cu	<1.0 mg/L	0	25	0	—
Fluoride, as F	<1.5 mg/L	3	42	0	4.6
Iron, as Fe	<0.3 mg/L	36	60	0	2.2
Lead, as Pb	<0.3 mg/L	2	5	22	0.70
Manganese, as Mn	<0.05 mg/L	41	63	0	0.35
Nitrate & Nitrite, as N	<10.0 mg/L	0	57	0	—
Sodium, as Na	<270.0 mg/L	7	66	0	309
Sulphate, as SO ₄	<500 mg/L	1	63	0	530
Total dissolved solids	<500 mg/L	15	53	0	1526
Turbidity	<5 NTU	6	22	0	14
Zinc, as Zn	<5.0 mg/L	0	26	0	—
Total		124	550	22	

¹From Table 4.1.

4.5.6 Suitability for Protection of Freshwater Aquatic Life

An analysis of surface-water data in relation to the guidelines for the protection of freshwater aquatic life (Table 4.21) indicated that almost 21% of the individual values were in noncompliance and 3 of the 11 parameters were always in compliance. The more frequent noncompliant parameters were cadmium (100%), copper (59%), iron (48%), pH (32%), and zinc (23%). These noncompliances correlate well with the upstream (upper and middle Saint John River basins) noncompliances except for phosphate. Closer examination of the phosphate data indicates that there are few noncompliances in the main stem (greater distance away from the agricultural belt along the Saint John River), and that most noncompliant values are from the agricultural areas of the Kennebecasis River.

4.6 Western Coastal Basin

4.6.1 Geology and Physiography

The western coastal basin (Fig. 1.8) is largely in the St. Croix Highlands. The geology is complex, ranging in age from Ordovician to Pennsylvanian. Rock types include metamorphosed and unmetamorphosed sedimentary rocks, volcanic rocks, and intrusives such as granites. The high elevations in the basin result from Devonian age intruded, resistant granites and related rocks.

Table 4.21. Noncompliance Analysis of Surface-Water Data in Relation to the Guidelines for the Protection of Freshwater Aquatic Life - Lower Saint John River Basin

Parameter	Guidelines ¹	Number of			Median of noncompliant values
		Noncompliant values	Included values	Excluded values	
Cadmium, as Cd	<0.0002 mg/L	131	131	239	0.002
Chromium, as Cr	<0.04 mg/L	0	52	0	—
Copper, as Cu	<0.005 mg/L	142	242	41	0.020
Iron (diss.), as Fe	<0.300 mg/L	0	135	0	—
Iron, as Fe	<0.300 mg/L	191	394	0	0.60
Lead, as Pb	<0.03 mg/L	2	307	34	0.085
Nickel, as Ni	<0.025 mg/L	0	4	0	—
Oxygen (diss.), as O ₂	>4.0 mg/L	6	914	1	3.1
pH	6.5-9.0	103	318	0	6.0
Phosphate (total), as P	<0.100 mg/L	35	516	0	0.271
Zinc, as Zn	<0.030 mg/L	87	375	0	0.064
Total		697	3388	315	

¹From Table 4.2.

4.6.2 Western Coastal Sub-basins

The western coastal basin is drained to the Bay of Fundy via three main rivers and their tributaries: the St. Croix along the U.S.-Canada border, the Digdeguash, and the Magaguadavic (sub-basin O1AR). The New Lepreau and Musquash rivers drain the northeastern part of the basin (sub-basin O1AQ).

4.6.3 Land Use and Economic Activity

The western coastal basin (O1AQ, O1AR) covers the Bay of Fundy drainage west of the St. John River basin. The population in this basin consists of approximately 4.4% of the provincial population. Most of the concentration is in the lower St. Croix River-Passamaquoddy Bay coastal area. The main urban areas are the towns of St. Stephen, St. Andrews (O1AR), and St. George (O1AQ). St. Stephen is the only community that provides municipal sewage treatment. Only one of the five villages in this basin provides central sewage treatment.

Roughly 74% of the western coastal basin is productive woodland. The remainder is chiefly nonproductive woodland, improved pasture and forage, outdoor recreational area, swamp, marsh, and bog.

The western coastal basin consists predominantly of softwood and mixed wood with small tracts of hardwood in the Grand-Spednik lakes and McAdam areas. Limited cutting activity has taken place, primarily in the lateral tract in the headwaters areas of the Magaguadavic and Digdeguash rivers. There is a small burn area just north of Pennfield Ridge. Limited reforestation has been undertaken in the McDougall Lake and Pocologan-New River areas of watershed O1AQ.

Industrial activity in the western coastal basin is mainly resource-based. Secondary industry is light and is focused in the St. Stephen area. Forest harvesting and commercial fishing and processing are the dominant activities. Agriculture is minor and declining. Water-based recreation is significant and widespread, with extensive angling, hunting, and cottage development. Specific industrial activities include a tin mine at Mount Pleasant, a pulp and paper mill at St. George, wood products at McAdam, a thermal generating station at Coleson Cove, a nuclear power plant at Point Lepreau, and an industrial park at Bayside.

4.6.4 Water Quality

The water chemistry data for the 68 surface-water sites contained in the data base are summarized in Table 4.22. The ground-water data were not summarized since the data base contained only two sites.

Table 4.22. Data Summary - Western Coastal Basin

Parameter	Surface water*
Alkalinity (total)	9.4
Aluminum (diss.)	0.128
Bicarbonate	7.4
Cadmium (ext.)	0.0017
Calcium	3.3
Chloride	3.7
Chromium (ext.)	0.0007
Copper (ext.)	0.0093
Iron (ext.)	0.217
Lead (ext.)	0.0154
Magnesium	0.7
Nickel (ext.)	0.0048
Oxygen (diss.)	8.8
pH	6.2†
Potassium	0.3
Sodium	2.1
Sulphate	4.9
Total dissolved solids	21.5
Zinc (ext.)	0.037

*Mean (mg/L).

†Median in pH units.

The surface waters of the western coastal basin are very dilute with mixed calcium bicarbonate/sodium chloride-sulphate composition and low total dissolved solids. The ground-water data, although very sparse, indicate a predominance of calcium carbonate with some sodium chloride.

4.6.5 Suitability for Domestic Consumption

The noncompliance analysis of the surface water data showed that out of the 18 parameters assessed, 6 were in noncompliance (Table 4.23), with cadmium and chloride being noncompliant very few times. The more frequent noncompliant parameters were iron (13%), manganese (16%), and pH (42%). The total percentage of noncompliant values was 3.3%.

Table 4.23. Noncompliance Analysis of Surface-Water Data in Relation to Maximum Acceptable Levels for Drinking Water - Western Coastal Basin

Parameter	Guidelines ¹	Number of			Median of noncompliant values
		Noncompliant values	Included values	Excluded values	
Arsenic, as As	<0.05 mg/L	0	27	4	—
Barium, as Ba	<1.0 mg/L	0	10	0	—
Boron, as B	<5.0 mg/L	0	34	0	—
Cadmium, as Cd	<0.005 mg/L	1	224	21	0.01
Chloride, as Cl	<250.0 mg/L	1	759	0	320.
Copper, as Cu	<1.0 mg/L	0	532	0	—
Fluoride	<1.5 mg/L	0	309	0	—
Iron, as Fe	<0.3 mg/L	58	464	0	0.36
Lead, as Pb	<0.05 mg/L	0	359	33	—
Manganese, as Mn	<0.05 mg/L	50	312	0	0.08
Nitrate & Nitrite	<10.0 mg/L	0	554	0	—
pH	6.5-8.5	106	253	0	6.1, 9.0
Selenium, as Se	<0.01 mg/L	0	4	0	—
Sodium, as Na	<270.0 mg/L	0	681	0	—
Sulphate, as SO ₄	<500 mg/L	0	745	0	—
Total dissolved solids	<500 mg/L	0	618	0	—
Turbidity	<5 NTU	25	830	0	7.0
Zinc, as Zn	<5.0 mg/L	0	486	0	—
Total		241	7201	58	

¹From Table 4.1.

4.6.6 Suitability for Protection of Freshwater Aquatic Life

The analysis of surface-water data in relation to the guidelines for the protection of freshwater aquatic life (Table 4.24) indicates that a total of 13% of the values are in noncompliance with only two of the ten parameters in constant compliance. The more frequent noncompliant parameters were copper (37%), iron (13%), pH (41%), and zinc (19%). The magnitude of the difference between the prescribed level and the median of noncompliant values was greatest for copper, dissolved oxygen, and pH. The copper noncompliance can be attributed to the geology. The low dissolved oxygen values are directly related to anthropogenic activities, especially the pulp and paper industry.

4.7 Eastern Coastal Basin

4.7.1 Geology and Physiography

Most of the eastern coastal basin (Fig. 1.9) lies in the New Brunswick Lowland. It is underlain by sedimentary rocks including red and grey sandstone, siltstone conglomerate and, locally, coal of Pennsylvanian age. In addition to Pennsylvanian age strata, about 10% of southeastern watershed OIBS and northern OIBU are underlain by Mississippian sandstones, shales, conglomerates, minor limestone, evaporites, and volcanic rock.

Table 4.24. Noncompliance Analysis of Surface-Water Data in Relation to the Guidelines for the Protection of Freshwater Aquatic Life - Western Coastal Basin

Parameter	Guidelines ¹	Number of			Median of noncompliant values
		Noncompliant values	Included values	Excluded values	
Chromium, as Cr	<0.04 mg/L	0	39	0	—
Copper, as Cu	<0.005 mg/L	176	473	59	0.03
Iron (diss.), as Fe	<0.300 mg/L	2	188	0	0.52
Iron, as Fe	<0.300 mg/L	58	464	0	0.36
Lead, as Pb	<0.03 mg/L	3	359	33	0.04
Nickel, as Ni	<0.025 mg/L	0	38	0	—
Oxygen (diss.), as O ₂	>4.0 mg/L	10	909	0	2.1
pH	6.5-9.5	104	253	0	6.1
Phosphate (total), as P	<0.100 mg/L	1	136	0	0.14
Zinc, as Zn	<0.030 mg/L	93	486	0	0.067
Total		447	3345	92	

¹From Table 4.2.

In the eastern Fundy region, the land rises through uplands to the Caledonian Highlands (approximately 30% of sub-basin O1BU and 50% of sub-basin O1BV). These highlands are geologically more complex than the lowlands of the province, consisting of bedrock ranging in age from Precambrian (the oldest rocks in New Brunswick) to Pennsylvanian (among the youngest rocks). A variety of rock types are featured, such as sandstones, shales, conglomerates, volcanics, intrusive igneous rocks, metamorphic equivalents of these, local coal deposits, and minor evaporites.

4.7.2 Eastern Coastal Sub-basins

Watershed O1BU drains to the Bay of Fundy via the Petitcodiac and Memramcook rivers, and eventually enters Shepody Bay. Sub-basin O1BV drains to the Bay of Fundy by various small rivers and streams such as the Big Salmon and Point Wolf rivers. Sub-basin O1BT drains to Cumberland Basin via the Tantramar, Missaguash, and Aulac rivers, and by various small rivers to Baie-Verte and the Northumberland Strait. Sub-basins O1BS and O1BR drain to the Gulf of St. Lawrence via such rivers as the Buctouche (to Northumberland Strait), the Richibucto and Kouchibouguac. Watershed O1BL drains east to the Gulf of St. Lawrence and north to Chaleur Bay via such rivers as the Tabusintac, Tracadie, Caraquet, and Bass.

4.7.3 Land Use and Economic Activity

The eastern coastal basin (O1BL, O1BR, O1BS, O1BT, O1BU, and O1BV) includes the entire Gulf of St. Lawrence drainage area (excluding the inner reaches of Miramichi Bay) from East Bathurst on Nepisiguit Bay down to the Nova Scotia border, as well as the Bay of Fundy drainage area east of the Saint John River basin. This basin covers roughly 19% of the province and contains 32% of the population.

Slightly less than half the population of the eastern coastal basin is found in the eastern Fundy sub-basins (O1BU, O1BV) along the Petitcodiac and Memramcook rivers. The major urban areas in these sub-basins are the city of Moncton and the towns of River View and Dieppe. Of the 11 municipalities in these two sub-basins, only 5 provide central sewage treatment.

The population of the St. Lawrence drainage sub-basin is concentrated along the coast itself, primarily at the estuaries. Roughly half of the St. Lawrence sub-basin's population is found within the Acadian Peninsula (O1BL). The eastern portion of the city of Bathurst lies in this area. Other urban centres in the St. Lawrence drainage portion of the eastern coastal basins include the towns of Caraquet, Shippegan, and Tracadie (O1BL), and Shediac and Sackville (O1BJ), all of which provide municipal sewage treatment. Of the 15 villages in these sub-basins, 9 provide central sewage treatment.

Roughly 62% of the St. Lawrence sub-basin and 73% of the eastern Fundy sub-basin is productive woodland. The remainder consists of improved pasture and forage area, nonproductive woodland, rough grazing and rangeland, outdoor recreational area in the eastern Fundy sub-basin, and swamp, marsh, and bog (notably peatlands), primarily in the St. Lawrence sub-basin (O1BL and O1BR).

The St. Lawrence sub-basin is predominantly softwood with scattered areas of mixed wood particularly in watersheds O1BL and O1BT. There are virtually no hardwood tracts here. Little cutting activity has taken place in this area, although cleared areas are found around Tracadie in O1BL, the Buctouche and Richibucto areas of O1BS, and along the coast of O1BT. There is a major burn area in watershed O1BL in the headwaters area of the Tracadie and Tabusintac rivers, as well as smaller burn areas in the head of the Black River (O1BR), the head of Coal Branch River (O1BS), and on the Tantramar River in O1BT. Significant reforestation efforts have been undertaken in the area of the northern headwaters of the Tabusintac and the southern headwaters of the Tracadie River. Other isolated efforts have been carried out in watersheds O1BR and O1BS. Forest cover in the eastern Fundy sub-basin is mainly softwood with tracts of mixed wood in the Loch Lomond area of O1BV and the area surrounding Fundy National Park, and a tract of hardwood in watershed O1BU. Limited cutting activity has taken place here, primarily in an isolated tract in watershed O1BV. There is a cleared area along the upper Petitcodiac River and North River area in watershed O1BU. Limited reforestation has been undertaken in the area just east of Fundy Park and in the central part of watershed O1BV.

Numerous coastal fish-processing plants are found along the stretch of the St. Lawrence sub-basin. Other industries include chemical products and a distillery in Richibucto, piggeries and other associated meat processing at Burnsville and Paquetville, silica extraction just east of Bathurst, and industrial parks at Bas-Caraquet and Scoudouc.

The major economic activity in the eastern Fundy sub-basin is forest harvesting. Secondary industry is concentrated in the Moncton area of watershed O1BU. Commercial fishing and agriculture are minor activities. Specific industrial activities in the area include chemical products at Hillsborough and Moncton, food processing just east of Moncton, the New Brunswick oilfields, and a number of industrial parks around Moncton and Dieppe.

4.7.4 Water Quality

The calculated mean value for the water chemistry data collected from the 52 surface-water sites contained in the data base are summarized in Table 4.25. The ground-water data were not summarized due to the wide range of concentrations found for many parameters in the eastern coastal basin.

Table 4.25. Data Summary - Eastern Coastal Basin

Parameter	Surface water*
Alkalinity (total)	18.4
Aluminum	0.11
Bicarbonate	16.7
Cadmium (ext.)	0.002
Calcium	6.3
Chloride	7.1
Copper (ext.)	0.018
Iron (ext.)	0.163
Lead (ext.)	0.013
Magnesium	1.1
Nickel (ext.)	0.014
Oxygen (diss.)	10.8
Potassium	0.7
Sodium	5.3
Sulphate	7.1
Total dissolved solids	45.1
Zinc (ext.)	0.02

*Mean (mg/L).

The surface waters are mainly of dilute calcium bicarbonate type, gradually becoming brackish in the lower reaches. In the southern portion, the surface waters have a mixed chemical composition of calcium bicarbonate/sodium chloride-sulphate with very low TDS. One notable exception is the Petitcodiac watershed where a high TDS was observed.

All of the ground-waters in this basin are more highly concentrated than the surface waters in the same vicinity. Their chemical composition was variable with only localized predominant types. The various water types found included sodium chloride, calcium bicarbonate, sodium bicarbonate, and calcium bicarbonate/sodium chloride-sulphate waters.

4.7.5 Suitability for Domestic Consumption

The noncompliance analysis of the surface-water data (Table 4.26) showed that out of 17 parameters analyzed, 10 were in noncompliance at least once, while 7 were in compliance all of the time. In terms of values, only 356 out of 7583 values or 4.6% of the total were in noncompliance. The more frequent noncompliant parameters were iron (27%), manganese (27%), pH (21%), and turbidity (10%). The magnitude of the difference between the guideline level and the median of the noncompliant values was greatest for cadmium, chloride, pH, sodium, sulphate, total dissolved solids (TDS), and turbidity. Many of the above had a very low frequency of noncompliance; i.e., cadmium (2%), chloride (1%), sodium (1%), sulphate (0.1%), and TDS (1%). Therefore, the problem parameters in respect to raw drinking water supplies are pH and turbidity. These noncompliances can be attributed to the geology and the presence of peat bogs.

Table 4.26. Noncompliance Analysis of Surface-Water Data in Relation to Maximum Acceptable Levels for Drinking Water - Eastern Coastal Basin

Parameter	Guidelines ¹	Number of			Median of noncompliant values
		Noncompliant values	Included values	Excluded values	
Arsenic, as As	<0.05 mg/L	0	11	0	—
Barium, as Ba	<1.0 mg/L	0	19	0	—
Boron, as B	<5.0 mg/L	0	16	0	—
Cadmium, as Cd	<0.005 mg/L	5	293	23	0.010
Chloride, as Cl	<250.0 mg/L	10	839	0	1047.
Copper, as Cu	<1.0 mg/L	0	426	0	—
Fluoride, as F	<1.5 mg/L	0	361	0	—
Iron, as Fe	<0.3 mg/L	101	376	0	0.41
Lead, as Pb	<0.05 mg/L	7	320	32	0.08
Manganese, as Mn	<0.05 mg/L	96	359	0	0.085
Nitrate & Nitrite, as N	<10.0 mg/L	0	694	0	—
pH	6.5-8.5	35	163	0	—
Sodium, as Na	<270.0 mg/L	8	823	0	850.
Sulphate, as SO ₄	<500 mg/L	1	837	0	1300.
Total dissolved solids	<500 mg/L	9	784	0	2490.
Turbidity	<5 NTU	84	842	0	13.
Zinc, as Zn	<5.0 mg/L	0	420	0	—
Total		356	7583	55	

¹From Table 4.1.

The ground-water noncompliance analysis (Table 4.27) indicate that 10 of the 13 parameters scrutinized exhibited noncompliances at least once. The more frequent noncompliant parameters were iron (34%), manganese (40%), TDS (11%), and turbidity (31%). The parameters with noncompliant median values that were at least twice the guideline level were iron, lead, manganese, sulphate, TDS, and turbidity. Some of the latter parameters, however, had a very low frequency of noncompliance. The problem parameters, therefore, are iron, manganese, TDS, and turbidity.

4.7.6 Suitability for Protection of Freshwater Aquatic Life

An analysis of surface-water data in relation to the guidelines for the protection of freshwater aquatic life (Table 4.28) indicate that a total of 14% of the individual values were in noncompliance with only one of the ten parameters in constant compliance. The more frequent noncompliant parameters are copper (34%), iron (27%), pH (21%), and zinc (18%). The magnitude of the difference between the guideline level and the median of the noncompliant values or the severity of the noncompliance is greatest with copper, lead, dissolved oxygen, phosphate, and zinc. Some of the latter, however, had very low frequencies of noncompliance and cannot be regarded as posing serious problems. The parameters of major concern are copper and zinc.

Table 4.27. Noncompliance Analysis of Ground-Water Data in Relation to Maximum Acceptable Levels for Drinking Water - Eastern Coastal Basin

Parameter	Guidelines ¹	Number of			Median of noncompliant values
		Noncompliant values	Included values	Excluded values	
Cadmium, as Cd	<0.005 mg/L	0	7	0	—
Chloride, as Cl	<250.0 mg/L	6	83	0	455.
Copper, as Cu	<1.0 mg/L	0	27	0	—
Fluoride, as F	<1.5 mg/L	5	68	0	2.2
Iron, as Fe	<0.3 mg/L	27	80	0	0.95
Lead, as Pb	<0.05 mg/L	3	10	16	0.2
Manganese, as Mn	<0.05 mg/L	32	80	0	0.7
Nitrate & Nitrite, as N	<10.0 mg/L	0	66	0	—
Sodium, as Na	<270.0 mg/L	6	81	0	410.
Sulphate, as SO ₄	<500 mg/L	1	59	0	1920.
Total dissolved solids	<500 mg/L	0	71	0	1118.
Turbidity	<5 NTU	13	42	0	24.
Zinc, as Zn	<5.0 mg/L	1	26	0	7.0
Total		102	700	16	

¹From Table 4.1.

Table 4.28. Noncompliance Analysis of Surface-Water Data in Relation to the Guidelines for the Protection of Freshwater Aquatic Life - Eastern Coastal Basin

Parameter	Guidelines ¹	Number of			Median of noncompliant values
		Noncompliant values	Included values	Excluded values	
Chromium, as Cr	<0.04 mg/L	0	17	0	—
Copper, as Cu	<0.005 mg/L	130	379	57	0.028
Iron (diss.), as Fe	<0.300 mg/L	2	219	0	0.36
Iron, as Fe	<0.300 mg/L	101	376	0	0.41
Lead, as Pb	<0.03 mg/L	10	320	32	0.068
Nickel, as Ni	<0.025 mg/L	2	22	0	0.030
Oxygen (diss.), as O ₂	>4.0 mg/L	1	498	0	2.0
pH	6.5-9.0	35	163	0	6.1
Phosphate (total), as P	<0.100 mg/L	12	177	0	0.295
Zinc, as Zn	<0.030 mg/L	74	420	0	0.050
Total		367	2591	89	

¹From Table 4.2.

CHAPTER FIVE

SPECIAL TOPICS

5.1 Acid Rain

Environmental contaminants generated in the industrial areas of eastern and central North America are transported by air currents and deposited far from their points of origin. This problem of long-range transport of airborne pollutants (LRTAP) has been identified as posing a potentially serious threat to waters of eastern Canada (Canada-U.S. Memorandum of Intent, 1981).

One type of contaminant transported by air currents are oxides of sulphur and nitrogen. These combine with the moisture in the air to produce what has become known as "acid rain." The pH of rain can vary, but the normal pH is usually about 5.6, which is the pH of distilled water in equilibrium with atmospheric carbon dioxide. In 1979, Shaw reported measurements of wet deposition in the Atlantic region that indicated that the pH of rain-water sometimes reached values of 4.0-4.5. He also reported an average deposition of 2.2-3.2 kg/ha per month of nitrate. Local sources were estimated to contribute only one quarter of the nitrate, with the most important being the Coulson Cove Electric Generating Station near Saint John. The remainder were attributed to long-range atmospheric transport.

The manner in which acid precipitation affects surface-water chemistry depends on the buffering capacity of the local bedrock (Kramer, 1978a). The chemical constituents controlling the buffering capacity within a watershed are the calcareous components of the sediments and bedrock, along with minor contribution from aluminum, iron and manganese oxides, and organic acids. When acid precipitation falls on areas underlain by limestone or other buffering materials, it is neutralized by these constituents and does not cause acidification of the surface waters. However, when acid rain falls on "sensitive" soils, i.e., those lacking calcium carbonate or other buffering materials, the acid is not neutralized. The rainwater remains acidic as it runs over and through the soil into the lakes and streams. The buffering capacity present in a watershed is therefore controlled by the mineralogy of its bedrock and the depositional pattern of unsolicited glacial cover (Kramer, 1978b).

The geology of the northwestern part of New Brunswick is rich in carbonates, but most of the province is made up of material sensitive to acid precipitation (Card *et al.*, 1981). Most of New Brunswick is composed of non-calcareous, siliceous sedimentary rock of moderate sensitivity to acid along with intrusions of granitoid rock with no buffering capacity. Soils in wooded areas are mostly podzols, which also have little buffering potential (Rubec, 1981).

The water quality data for New Brunswick indicate that permanent acidification of surface waters has not yet occurred. Clair *et al.* (1982) have shown that water pH levels of most surface waters in the province are above 6.0. An exception noted was an area midway between Fredericton and St. Andrews where the mean annual surface water pH levels dipped below 5.5 (Fig. 5.1). The Lepreau River watershed occupies much of the area and has the lowest pH values in the province. Bedrock geology for this area is composed of felsic volcanic rock and offers little buffering capacity. The sensitivity index used by Clair *et al.* (1982) confirmed that this area is the most sensitive in the province (Fig. 5.2). They concluded that although most of New Brunswick had not been shown to be seriously affected by acid precipitation, the southwestern part of the province appeared to be very sensitive to change and could conceivably show effects in the near future.

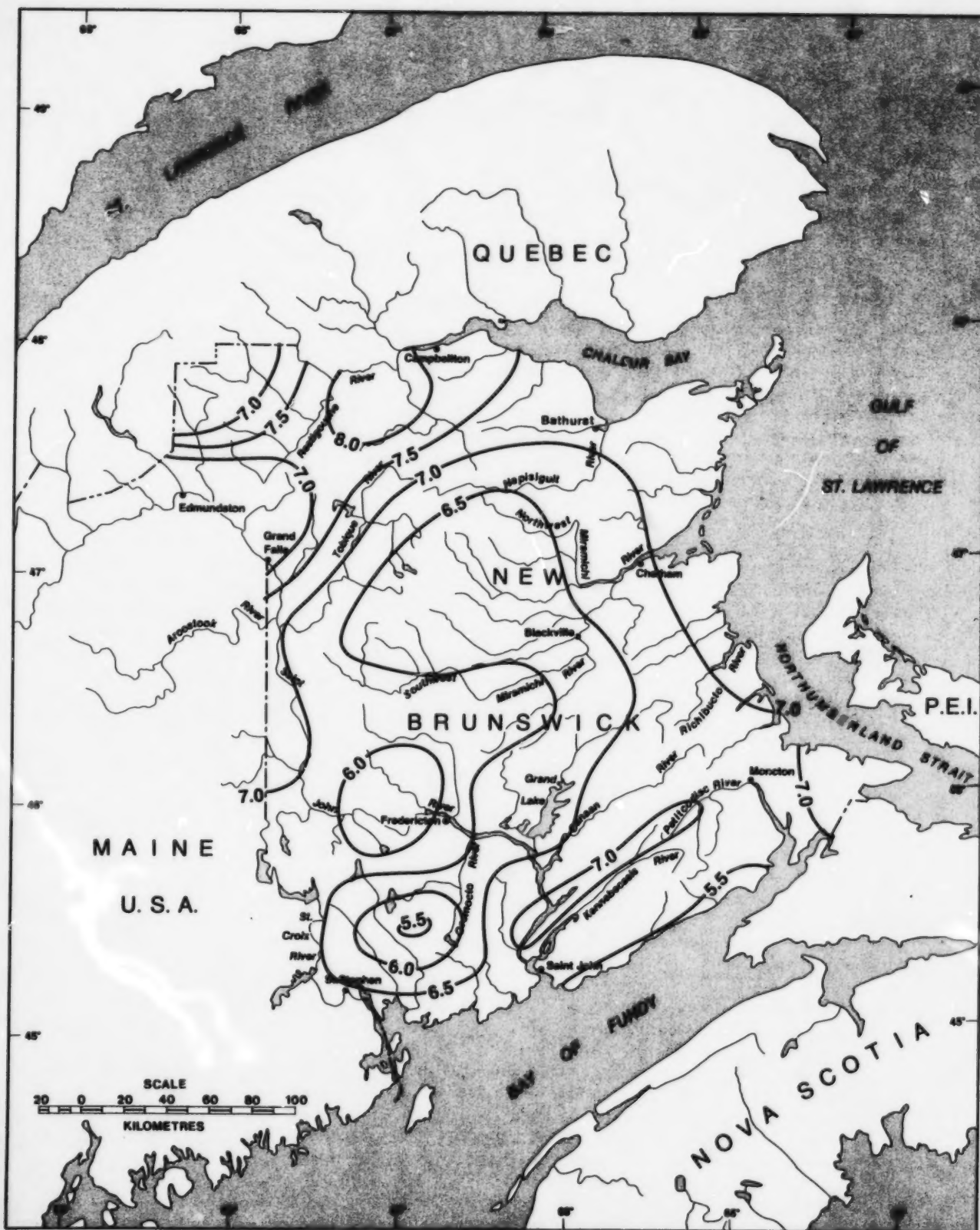


FIGURE 5.1 pH DISTRIBUTION

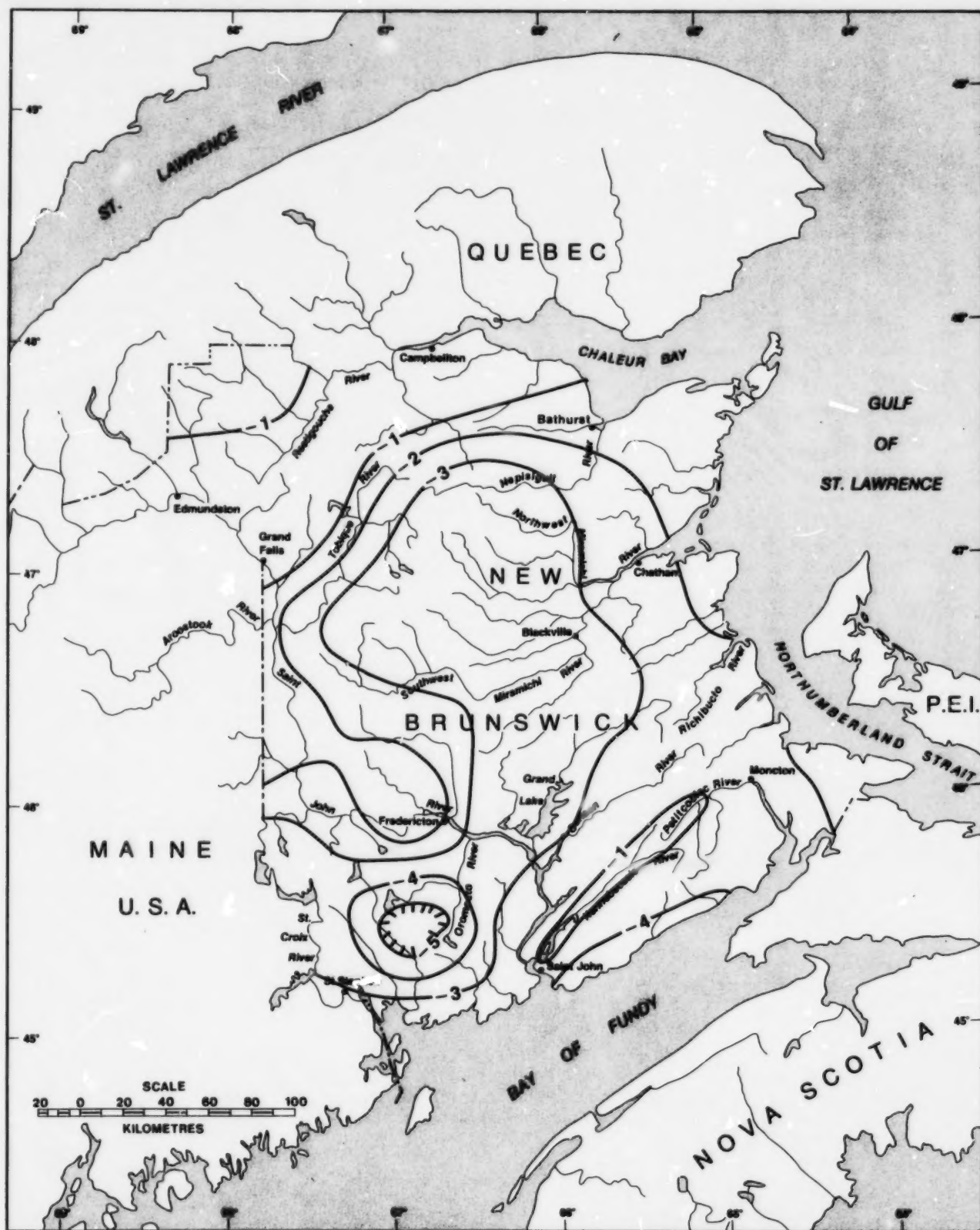


FIGURE 5.2

DISTRIBUTION OF CALCITE SATURATION INDEX VALUES

Analysis of surface-water quality data shows that pH levels are quickly depressed during spring snowmelt. This drop in pH levels can be greater than one pH unit, but only lasts for a few weeks each year. This observation agrees with similar studies in Ontario (Jefferies *et al.*, 1979), which showed that acids in snow cover are normally washed out during the initial melt.

In summary, most of New Brunswick's surface waters are moderately sensitive to acid precipitation. Those in the northeastern portion of the province are the least sensitive, whereas those in the southwestern part are the most sensitive.

5.2 Toxic Substances

Environment Canada (1980) defines toxic substances as "those chemical substances which, when released to the environment, or thereafter, if chemically transformed through combination or otherwise, could pose a significant threat to natural ecosystems, to human health and well-being." Some toxic substances tend to be highly refractory once released to the environment. They are capable of causing biological changes at trace concentrations, and some are concentrated in the food chain (bioaccumulation). Once they reach the environment, these substances are essentially irretrievable and their effects can, within a time span meaningful for human societies, be irreversible.

The state of knowledge about individual toxic substances in the aquatic environment of New Brunswick is considerably different as a result of changing concerns and priorities for information over the years. The substances presently under scrutiny or considered potentially hazardous are listed in Table 5.1.

5.2.1 Inorganic Substances

Inorganic substances constitute a small portion of the list and are usually naturally occurring trace elements. They often re-enter the environment via aqueous pathways such as process waters from the primary industries of mining and concentration and from smelting plants, and from emissions to the atmosphere associated with mining, concentration, and smelting industries. Wells drilled in water-bearing formations containing arsenopyrites may inadvertently introduce arsenic into drinking water.

Since these substances are toxic at low concentrations, they are often employed as preservatives for exposed structures. However, in the weathering process some of these compounds will slowly be reintroduced to the environment. A legacy in New Brunswick is the mercury that was used to preserve seed grain and the wood stockpiled at pulp and paper mills.

One other major source of inorganic toxic substance in surface and ground waters is the transportation industry. Fuel additives are deposited along roadways from exhaust emissions. These deposits may in turn be washed off to a nearby stream or be incorporated into the ground water by migration through the soil.

In addition to industrial sources, the ongoing dissolution of copper pipes and lead solder joints associated with urban life can represent a significant contribution. Ironically, this contribution is most significant in areas where the waters are soft and considered to be pristine.

Table 5.1. Status of Toxic Substances in the Atlantic Provinces

Group 1: Extensively studied in the Atlantic provinces, status and problem areas well defined:

- cadmium
- chlorobenzenes
- mercury
- polychlorinated biphenyls (PCBs)

Group 2: Of concern in the Atlantic provinces, but not well studied or evaluated:

- triaryl phosphate (TAP)
- chlorophenols
- dioxins
- lead
- organotins
- phthalate acid esters (PAEs)
- polynuclear aromatic hydrocarbons (PAHs)

Group 3: Little or no information available on their presence in the Atlantic provinces:

- bromobenzenes
- chloroethanes
- chloroethers
- chlorinated naphthalenes
- chlorinated paraffins
- chlorotoluenes
- polychlorinated terphenyls (PCT)
- di- and tri-ethanolamine
- hexachlorocyclopentadiene and adducts
- fluorochloromethanes

Group 4: Not presently believed to be a problem in the Atlantic provinces:

- beryllium
- formaldehyde
- mirex
- polybrominated biphenyls (PBBs)
- selenium
- silver
- thallium

Source: Matheson *et al.*, 1979.

5.2.2 Organic Compounds

5.2.2.1 Inadvertently Toxic

Most of the compounds listed in Table 5.1 were synthesized for specific purposes such as durable plastics, temperature-stable insulating fluids, and nonvolatile cleaning fluids. These very properties, nonvolatility and stability, which made them so useful, proved to be liabilities when they were disposed of or escaped to the environment. None of these compounds are very soluble in water; they tend to be lipophilic. This leads to their bioaccumulation in the food chain (Travers and Wilson, 1977). The compounds that fall into this category in New Brunswick include the polychlorinated biphenyls, phthalate acid esters, chlorinated benzenes, and chlorinated paraffins.

5.2.2.2 Pesticides

Pesticides are specifically synthesized to be toxic and to be introduced deliberately into the environment. They may be employed as herbicides, insecticides, fungicides, or acaricides. Again the very properties that made these compounds initially effective (toxic, long-acting, broad range of target organisms), contribute to their off-target impact on the environment. It has become an accepted part of forestry management in New Brunswick to employ pesticides in order to ensure continued pulpwood supplies. Present-day technology has increased the specificity and decreased the half-life of the parent pesticide compounds. Monitoring results indicate that measurable effects in the aquatic environment are restricted to a matter of hours or days after application for most active ingredients (Matheson *et al.*, 1979). The toxicity and persistence of metabolites and decomposition products are less well characterized. Impurities in commercial pesticides can represent significant environmental concerns. The classic example of this is the presence of dioxins and dibenzofurans in trace quantities in chlorophenols and chlorinated phenoxy-acid herbicides. These same toxics appear as by-products in the incineration of chlorinated aromatic compounds unless conditions are very carefully controlled.

The other major user of pesticides with the potential to enter the aquatic environment through wash-off or erosion, is the agricultural industry. This has been dealt with in Section 3.1.1.

5.2.2.3 Wastes

Waste disposal in landfills is another potential source of toxics to the environment. Plasticizers, waste solvents, and surplus or residual chemicals from households and industries may enter ground or surface waters when disposed of in this manner. Recognition of this problem has provided the impetus for development of a hazardous waste strategy.

Most of the data collected during the review period (1961-1979) do not lend themselves to interpretation vis-à-vis the real or potential environmental impact of toxic substances, mainly because the data were not collected for that purpose.

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APPENDIX A
NAQUADAT PARAMETER CODES

Parameter description	Units	NAQUADAT code(s)*
1. Acidity, as CaCO ₃	mg/L	10201;10;11;51
2. Alkalinity, Phenol, as CaCO ₃	mg/L	10151
3. Alkalinity, Total, as CaCO ₃	mg/L	10101;02;03;04;05;06;07;08;09
4. Ammonia, Dissolved, as N	mg/L	07551;52;53;54;55;56;57;58;59;60;61
5. Antimony, as Sb	mg/L	51101;02;301;302;201;001;002;003
6. Arsenic, as As	mg/L	33101;03;04;05;06;301;303;304;001;003; 005;006;007
7. Bicarbonate, as HCO ₃	mg/L	06201;99;02
8. Cadmium, as Cd	mg/L	48101;02;03;04;11;301;302;303;305;399; 000;001;003;006;007
9. Calcium, as Ca	mg/L	20110;00;01;02;03;04;05;07;08
10. Carbon, Dissolved Inorganic, as C	mg/L	06105;51;52
11. Carbon, Dissolved Organic, as C	mg/L	06101;03;04
12. Carbon, Total Inorganic, as C	mg/L	06051;52;53
13. Carbon, Total Organic, as C	mg/L	06002;01;03;04;05;07;08
14. Carbonate, as CO ₃	mg/L	06301;02
15. Chloride, as Cl	mg/L	17201;02;03;04;05;06;07;08
16. Chlorophyll A	mg/L	06708;11;16
17. Chromium, as Cr	mg/L	24052;53;302;303;305;000;001;002;003;004
18. Cobalt, as Co	mg/L	27054;101;102;303;301;302;001;002;003
19. Colour, Apparent	TCU	02001;17
20. Copper, as Cu	mg/L	29101;02;04;05;06;07;08;301;303;304; 003;004;005;006
21. Discharge, Daily Mean	cfs	97163

*Only the most frequently used codes are identified.

Parameter description	Units	NAQUADAT code(s)*
22. Fluoride, as F	mg/L	09101;02;03;04;05
23. Hardness, Total, as CaCO ₃	mg/L	10603;04;05
24. Iron, as Fe	mg/L	26101;02;04;05;301;302;303;304;002;003; 004;005
26. Magnesium, as Mg	mg/L	12102;03;04;05;06;101;002
27. Manganese, as Mn	mg/L	25101;03;04;05;301;303;304;004;005;008
28. Mercury, as Hg	µg/L	80311;12;13;14;011;013;014
29. Molybdenum, as Mo	mg/L	42101;02;11;303;301;001;002;005
30. Nickel, as Ni	mg/L	28101;02;303;301;001;002;004
31. Nitrate plus Nitrite, Dissolved, as NO ₃	mg/L	07103
32. Nitrogen, Dissolved, as N	mg/L	07651
33. Nitrogen, Dissolved Kjeldahl, as N	mg/L	07017;51
34. Nitrogen, Nitrate, as N	mg/L	07319;01;06
36. pH	units	10301;02
37. Phosphate, as P or PO ₄	mg/L	15453;353;254;402;403;356;255;260;406; 405;409
38. Potassium, as K	mg/L	19101;02;03;04;05
39. Residue	mg/L	10451;52;551;501;571;401;402;471;472;519
40. Silica, Reactive, as SiO ₂	mg/L	14101;02;05
41. Silver, as Ag	mg/L	47101;02;301;302;001;002
42. Sodium, as Na	mg/L	11101;02;03;04;05
43. Specific Conductance	µS/cm	02041;42
44. Sulphate, as SO ₄	mg/L	16301;02;03;04;05;07
45. Temperature	°C	02061;62;63
46. Turbidity	JTU	02071;72;73
47. Zinc as Zn	mg/L	30101;02;03;04;05;305;306;307;004;005; 006

APPENDIX B

STATION LISTING

STATION 00BRO1AF0042

LAT. = 47D 3M 30S LONG. = 67D 45M 55S

Description: Saint John River at TCH bridge, Grand Falls N Gridley New Brunswick Electric Power Commission, June 1979.

STATION 00BRO1AJ0030

LAT. = 46D 9M 55S LONG. = 67D 34M 10S

Description: Saint John River at Grafton bridge, Woodstock N Gridley New Brunswick Electric Power Commission, June 1979.

STATION 00BRO1AK0004

LAT. = 45D 57M 38S LONG. = 66D 38M 25S

Description: Suspended Sediment Survey, Saint John River at Fredericton, station 1, centre of second span from right on Carleton Street bridge.

STATION 00BRO1AK0006

LAT. = 45D 58M 3S LONG. = 66D 38M 14S

Description: Suspended Sediment Survey, Saint John River at Fredericton, station 3, centre of seventh span from right on Carleton Street bridge.

STATION 00BRO1AK0007

LAT. = 45D 57M 25S LONG. = 66D 59M 22S

Description: Suspended Sediment Survey, Saint John River at Fredericton, station 4, centre of ninth span from right of Carleton Street bridge.

STATION 00BRO1AK0017

LAT. = 45D 50M 05S LONG. = 67D 04M 27S

Description: Lake George Outlet, station 1, bridge of Hwy 635 on Pokiok Stream.

STATION 00BRO1AK0018

LAT. = 45D 57M 36S LONG. = 67D 14M 32S

Description: Pokiok Stream, mouth, station 2, Saint John River.

STATION 00BRO1AK0045

LAT. = 45D 59M 40S LONG. = 66D 50M 15S

Description: Keswick River BACTI T-8, Keswick, York County, June 1977. Sample taken 100 m above point where Route 105 crosses Keswick River.

STATION 00BRO1AK0046

LAT. = 45D 58M 0S LONG. = 66D 42M 20S

Description: Garden Creek BACTI T-9, Fredericton, where Woodstock Road crosses Garden Creek.

STATION 00BRO1AK0084

LAT. = 46D 0M 50S LONG. = 66D 50M 10S

Description: Keswick River, station 2, Keswick, York County, May 1978. Sample taken at site of Colter bridge.

STATION OOBROIAK0086

LAT. = 46D 3M 25S LONG. = 66D 52M 15S

Description: Keswick River, station 4, Burtts Corner, York County, May 1978. Sample taken 450 m above confluence with Jones Forks Brook.

STATION OOBROIAK0087

LAT. = 46D 4M 20S LONG. = 66D 51M 55S

Description: Keswick River, station 5, Jones Forks, York County, May 1978. Sample taken from Jones Forks Brook on Route 617.

STATION OOBROIAK0088

LAT. = 46D 3M 15S LONG. = 66D 56M 10S

Description: Keswick River, station 6, Zealand, York County, May 1978. Sample taken at creosote beam bridge over Keswick River.

STATION OOBROIAK0089

LAT. = 46D 5M 15S LONG. = 66D 57M 20S

Description: Keswick River, station 7, Stoneridge, York County, May 1978. Sample taken at covered bridge over Keswick River.

STATION OOBROIAK0090

LAT. = 46D 5M 40S LONG. = 66D 57M 15S

Description: Keswick River, station 8, Stoneridge, York County, May 1978. Sample taken at bridge over North Forks (brook) at Stoneridge.

STATION OOBROIAK0091

LAT. = 45D 14M 25S LONG. = 67D 4M 0S

Description: West Keswick River, station 9, Barton, York County, May 1978. Sample taken 450 m up West Keswick from confluence with East Keswick River.

STATION OOBROIAK0092

LAT. = 46D 8M 30S LONG. = 67D 1M 40S

Description: Keswick River, station 10, Barton, York County, May 1978. Sample taken 450 m up Keswick River from confluence with West Keswick River.

STATION OOBROIAK0095

LAT. = 45D 57M 10S LONG. = 66D 53M 00S

Description: Mactaquac headpond, Saint John River, 500 m above hatchery intake above dam, June 1979.

STATION OOBROIAK0097

LAT. = 45D 58M 55S LONG. = 66D 53M 45S

Description: Mactaquac Park dam, approx. 500 m from Hwy 105 causeway.

STATION OOBROIAK0098

LAT. = 45D 57M 40S LONG. = 67D 14M 50S

Description: Nackawic, Saint John River at Pokiok bridge.

STATION OOBROIAL0001

LAT. = 46D 7M 35S LONG. = 66D 36M 45S

Description: Nashwaak River at Durham bridge, York County.

STATION OOBROIAL0002

LAT. = 46D 20M 35S LONG. = 67D 0M 5S

Description: Napadogan Brook from Valley Forest Products bridge, York County.

STATION OOBROIAL0004

LAT. = 46D 08M 25S LONG. = 66D 37M 15S

Description: Dunbar Stream, on right bank just above hwy bridge, York County.

STATION OOBROIAL0005

LAT. = 46D 1M 55S LONG. = 66D 34M 20S

Description: Penniac Stream, station 1, Penniac, York County. Taken at bridge over stream on Route 628 near mouth.

STATION OOBROIAL0007

LAT. = 45D 57M 20S LONG. = 66D 37M 20S

Description: Nashwaak River, station 1, Fredericton, York County. Taken from left downstream bank below bridge at mouth.

STATION OOBROIAL0008

LAT. = 45D 57M 55S LONG. = 66D 35M 20S

Description: Nashwaak River, station 2, Fredericton, York County. Taken below Town of Marysville, 80 m above power line crossing.

STATION OOBROIAL0009

LAT. = 46D 0M 30S LONG. = 66D 35M 0S

Description: Nashwaak River, station 3, Penniac, York County. Taken immediately above the Penniac bridge, downstream, left bank.

STATION OOBROIAL0010

LAT. = 46D 10M 20S LONG. = 66D 38M 25S

Description: Nashwaak River, station 4, Nashwaak Village, York County. Taken from gravel pit pool, downstream, right bank, access above Dunphy farm.

STATION OOBROIAL0011

LAT. = 46D 16M 55S LONG. = 66D 39M 20S

Description: Nashwaak River, station 6, Taymouth, York County. Taken immediately above Taymouth bridge, downstream, right bank.

STATION OOBROIAL0014

LAT. = 46D 17M 5S LONG. = 66D 44M 30S

Description: Nashwaak River, station 9, Stanley, York County. Taken 10 m above Stanley bridge, downstream, right bank.

STATION OOBROIAL0020

LAT. = 46D 18M 30S LONG. = 66D 39M 30S

Description: Tay River, tributary three, Taymouth, York County. Taken 10 m above bridge on Route 8.

STATION OOBROIAM0001

LAT. = 45D 50M 50S LONG. = 66D 31M 5S

Description: Oromocto River, station 1. Taken from railroad bridge.

STATION OOBROIAM0002

LAT. = 45D 46M 0S LONG. = 66D 33M 5S

Description: Oromocto River, station 2. Taken from road bridge on Route 7.

STATION OOBRO1AM0003

LAT. = 45D 37M 55S LONG. = 66D 34M 5S

Description: South Oromocto River, station 3. Taken from road bridge on Route 101 from South Oromocto River.

STATION OOBRO1AM0005

LAT. = 45D 39M 25S LONG. = 66D 36M 30S

Description: Oromocto River, station 5, Northwest Oromocto River. Taken from road bridge at Fredericton.

STATION OOBRO1AM0006

LAT. = 45D 40M 25S LONG. = 66D 41M 0S

Description: Oromocto River, station 6, Northwest Oromocto River. Taken from road bridge at Tracy.

STATION OOBRO1AM0007

LAT. = 45D 40M 40S LONG. = 66D 45M 35S

Description: Oromocto River, station 7, Northwest Oromocto River.

STATION OOBRO1AM0009

LAT. = 45D 48M 15S LONG. = 66D 37M 15S

Description: Oromocto River, station 9, North Rusagonis River. Taken at covered bridge at Rusagonis.

STATION OOBRO1AM0013

LAT. = 45D 51M 19S LONG. = 66D 28M 32S

Description: Oromocto River, station 1, Sunbury County. Taken at mouth of Oromocto River directly from the boat club.

STATION OOBRO1AM0016

LAT. = 45D 46M 15S LONG. = 66D 29M 30S

Description: Oromocto River, Snake Creek, station 5, Sunbury County. Taken at culvert on new road, Snake Creek.

STATION OOBRO1AM0023

LAT. = 45D 48M 24S LONG. = 66D 37M 25S

Description: North Rusagonis River, station 2, near Rusagonis. Taken 0.8 km up north branch.

STATION OOBRO1AM0026

LAT. = 45D 52M 15S LONG. = 66D 47M 10S

Description: North Rusagonis River, station 5, Sunbury County. Taken from right bank of North Rusagonis River.

STATION OOBRO1AM0027

LAT. = 45D 50M 50S LONG. = 66D 41M 10S

Description: North Rusagonis River, station 6. Taken where river crosses road between New Maryland and Mazonworth.

STATION OOBRO1AM0029

LAT. = 45D 48M 00S LONG. = 66D 37M 30S

Description: South Rusagonis River, station 1, Gladstone Parish, Sunbury County. Taken below bridge above Rusagonis.

STATION OOBRO1A#0043

LAT. = 46D 0M 55S LONG. = 66D 12M 45S

Description: Little River, station M-1, Minto, Sunbury County. Taken 20 m below bridge on Route 10.

STATION OOBRO1A#0044

LAT. = 46D 2M 40S LONG. = 66D 12M 05

Description: Eighteen Brook, station T-1, Minto, Sunbury County. Taken at stream crossing 0.8 km above confluence with Little River.

STATION OOBRO1A#0045

LAT. = 46D 01M 15S LONG. = 66D 14M 00S

Description: Miles Brook, station T-2, Minto, Sunbury County. Taken at bridge 0.75 m above confluence with Little River.

STATION OOBRO1A#0046

LAT. = 46D 3M 20S LONG. = 66D 12M 30S

Description: Little River, station 2, Minto, Sunbury County. Taken at point 2.5 km above confluence with Eighteen Brook.

STATION OOBRO1A#0051

LAT. = 66D 11M 55S LONG. = 46D 02M 39S

Description: Eighteen Brook, Minto, Sunbury County. Taken at road crossing below N.B. Coal Strip Mine.

STATION OOBRO1AP0001

LAT. = 45D 46M 45S LONG. = 65D 29M 10S

Description: Kennebecasis River survey at covered bridge 0.8 km up Smith Creek on Hwy 890.

STATION OOBRO1AP0002

LAT. = 45D 49M 45S LONG. = 65D 26M 43S

Description: Smith Creek at covered bridge near Mount Pisgah.

STATION OOBRO1AP0006

LAT. = 45D 49M 40S LONG. = 65D 13M 14S

Description: Kennebecasis River at first bridge on Tr 895 off Hwy 2.

STATION OOBRO1AP0007

LAT. = 45D 42M 8S LONG. = 65D 36M 05

Description: Kennebecasis River below dam at mouth of Studholm Mill Stream.

STATION OOBRO1AP0008

LAT. = 45D 42M 7S LONG. = 65D 36M 55S

Description: Kennebecasis River Survey, bridge at Lower Millstream on Studholm Mill Stream.

STATION OOBRO1AP0010

LAT. = 45D 46M 45S LONG. = 65D 35M 59S

Description: Kennebecasis River Survey, bridge at Berwick on Studholm Mill Stream.

STATION OOBRO1AP0015

LAT. = 45D 46M 30S LONG. = 65D 22M 21S

Description: Kennebecasis River, south bridge at mouth at Hwy 2.

STATION OOBRO1AP0020

LAT. = 45D 28M 5S LONG. = 65D 43M 17S

Description: Kennebecasis River Survey, bridge on road to Barnesville on Hammond River.

STATION OOBRO1AP0021

LAT. = 45D 25M 48S LONG. = 65D 53M 12S

Description: Kennebecasis River Survey, covered bridge at French Village on Hammond River.

STATION OOBRO1AP0025

LAT. = 45D 32M 34S LONG. = 65D 50M 10S

Description: Kennebecasis River at Hampton bridge.

STATION OOBRO1AP0026

LAT. = 45D 32M 42S LONG. = 65D 50M 3S

Description: Kennebecasis River, downstream from Hampton sewage treatment lagoon outflow.

STATION OOBRO1AP0031

LAT. = 45D 38M 15S LONG. = 65D 41M 49S

Description: Kennebecasis River, hwy bridge at Norton on Kennebecasis River.

STATION OOBRO1AP0033

LAT. = 45D 42M 5S LONG. = 65D 36M 7S

Description: Kennebecasis River, bridge at Apohaqui.

STATION OOBRO1AP0035

LAT. = 41D 34M 24S LONG. = 32D 49M 38S

STATION OOBRO1AP0039

LAT. = 45D 42M 42S LONG. = 65D 26M 31S

Description: Kennebecasis River at bridge by machine shed on Sussex Golf Course.

STATION OOBRO1AP0041

LAT. = 45D 43M 54S LONG. = 62D 28M 22S

Description: At culvert on TCH 0.5 km east of McCogle Road in tributary of Kennebecasis River (unnamed).

STATION OOBRO1AP0042

LAT. = 45D 43M 27S LONG. = 65D 30M 33S

Description: Kennebecasis River Survey at hwy railroad bridge in Sussex on Trout Creek.

STATION OOBRO1AP0043

LAT. = 45D 42M 43S LONG. = 65D 28M 33S

Description: Kennebecasis River Survey at bridge over Trout Creek by Sussex Corner.

STATION OOBRO1AP0047

LAT. = 45D 43M 17S LONG. = 65D 29M 17S

Description: Trout Creek at outflow of Sussex Corner sewage treatment lagoon.

STATION OOBRO1AP0048

LAT. = 45D 44M 1S LONG. = 65D 30M 38S

Description: Trout Creek at outflow of Sussex aeration ditch.

STATION 00BR01AP0054

LAT. = 45D 45M 40S LONG. = 65D 29M 50S

Description: Smith Creek, station 3, Kings County. Taken at bridge on secondary road of Hwy 890 about 4.0 km from mouth.

STATION 00BR01AP0055

LAT. = 45D 46M 0S LONG. = 65D 29M 55S

Description: Smith Creek, station 4, Kings County, taken 0.8 km above station 3 just below Plaggemborg farm.

STATION 00BR01AP0056

LAT. = 45D 47M 20S LONG. = 65D 29M 10S

Description: Smith Creek, station 5, Kings County, taken from covered bridge at Smith Creek above station 4.

STATION 00BR01AP0057

LAT. = 45D 48M 45S LONG. = 65D 27M 40S

Description: Smith Creek, station 6, Kings County, taken at bridge on road joining Hwy 890 to Knightville Road near community of Smith Creek.

STATION 00BR01AP0060

LAT. = 45D 52M 15S LONG. = 65D 23M 30S

Description: Smith Creek, station 9, Kings County, taken at bridge on road joining Hwy 890 and community of Knightville.

STATION 00BR01AP0061

LAT. = 45D 53M 15S LONG. = 65D 22M 15S

Description: Smith Creek, station 10, Kings County, taken from road joining Hwy 890 and Anagance, 5.0 km above station 9.

STATION 00BR01AP0062

LAT. = 45D 44M 30S LONG. = 65D 32M 20S

Description: McGregor Brook-Smith Creek, station 11, Kings County, taken at stream crossing on gravel pit road, 3.0 km from Roachville.

STATION 00BR01AP0114

LAT. = 45D 32M 40S LONG. = 65D 39M 5S

Description: Salt Springs Brook, station 1, Salt Springs, Kings County, taken at bridge on Route 860 between Salt Springs and Clover Hill.

STATION 00BR01AP0115

LAT. = 45D 33M 20S LONG. = 65D 38M 55S

Description: Scoodic Brook, station 1, Upham, Kings County, taken below bridge on Route 820 near DOH garage.

STATION 00BR01AP0116

LAT. = 45D 29M 30S LONG. = 65D 39M 0S

Description: Scoodic Brook, station 2, Upham, Kings County, taken about 150 m above bridge on Route 820 above DOH salt storage shed.

STATION 00BR01AP0117

LAT. = 45D 33M 20S LONG. = 65D 34M 15S

Description: Fowler Brook, station 1, Hillsdale, Kings County, taken at bridge on Route 261 between Hillsdale and Clover Hill.

STATION OOBRO1AP0118

LAT. = 45D 28M 35S LONG. = 65D 42M 50S

Description: Kennebecasis River, salt monitoring 1, McCully Station, Kings County, taken from main channel on north side of flood plain.

STATION OOBRO1AP0119

LAT. = 45D 45M 35S LONG. = 65D 25M 11S

Description: Kennebecasis River, salt monitoring 2, McCully Station, Kings County, secondary river channel in middle of flood plain on McCully Station Road.

STATION OOBRO1AP0120

LAT. = 45D 44M 25S LONG. = 65D 25M 05

Description: Kennebecasis tributary, salt monitoring 3, Penobsquis, Kings County, taken at stream crossing on TCH 100 m east of McCully Road.

STATION OOBRO1AP0121

LAT. = 45D 44M 30S LONG. = 65D 26M 50S

Description: Kennebecasis River, salt monitoring 4, Plumweseep, Kings County, taken at covered bridge off TCH near junction of Route 111.

STATION OOBRO1AP0122

LAT. = 45D 44M 30S LONG. = 65D 26M 45S

Description: Salt Pond-Kennebecasis tributary, salt monitoring 5.

STATION OOBRO1AP0123

LAT. = 45D 34M 20S LONG. = 65D 33M 30S

Description: North Branch Hammond River, station 1, Marchbank, Kings County, taken at river crossing on Route 248 near Marchbank.

STATION OOBRO1AP0124

LAT. = 45D 33M 10S LONG. = 65D 33M 30S

Description: North Branch Hammond River, station 2, Hillsdale, Kings County, taken at bridge between Marchbank and Hillsdale on Route 11.

STATION OOBRO1AQ0012

LAT. = 45D 41M 20S LONG. = 67D 10M 55

Description: Magaguadavic River, station M-1, Thomaston Corner, York County, taken at CPR crossing at beginning of Magaguadavic Lake 5.0 km from hwy at dam.

STATION OOBRO1AQ0013

LAT. = 45D 39M 35S LONG. = 67D 7M 45S

Description: Magaguadavic River, station M-2, Thomaston Corner, York County, taken at bridge at Thomaston Corner on Route 4.

STATION OOBRO1AQ0014

LAT. = 45D 40M 55S LONG. = 67D 5M 50S

Description: Northeast Magaguadavic River, station T-1, York Mills, York County, taken at bridge on Route 3 at mill.

STATION OOBRO1AQ0015

LAT. = 45D 31M 50S LONG. = 67D 6M 50S

Description: Magaguadavic River, station M-3, Upper Brockway, York County, 5 m off Route 3 on road to Tweedside bridge.

STATION OOBRO1AQ0016

LAT. = 45D 27M 25S LONG. = 67D 1M 0S

Description: Magaguadavic River, station M-4, Flume Ridge, Charlotte County, taken at bridge at Flume Falls off Flume Ridge Road, 8.0 km from Route 3.

STATION OOBRO1AQ0017

LAT. = 45D 23M 45S LONG. = 66D 55M 20S

Description: Magaguadavic River, station M-5, Pleasant Ridge, Charlotte County, taken 5.0 km from Pleasant Ridge at covered bridge.

STATION OOBRO1AQ0018

LAT. = 45D 25M 10S LONG. = 66D 55M 20S

Description: Piskahegan River, station T-2, Pleasant Ridge, Charlotte County, taken at covered bridge on Pleasant Ridge Road.

STATION OOBRO1AQ0019

LAT. = 45D 16M 25S LONG. = 66D 48M 25S

Description: Magaguadavic River, station M-6, Bonny River, Charlotte County, taken off Second Falls Road towards Lee Settlement at covered bridge 2.5 km in.

STATION OOBRO1AQ0020

LAT. = 45D 19M 55S LONG. = 66D 52M 35S

Description: Magaguadavic River, station M-7, Second Falls, Charlotte County, taken at bridge off road in Second Falls.

STATION OOBRO1AQ0022

LAT. = 45D 16M 10S LONG. = 66D 52M 55S

Description: Magaguadavic River, station M-8, St. George, Charlotte County, taken 5.5 km down from Bonny River beside highway to St. George.

STATION OOBRO1AQ0023

LAT. = 45D 14M 20S LONG. = 66D 51M 30S

Description: Magaguadavic River, station M-9, St. George, Charlotte County, taken at overpass on main road from Bonny River, 100 m before main town.

STATION OOBRO1AQ0025

LAT. = 45D 9M 35S LONG. = 66D 51M 40S

Description: Lake Utopia tributary, station T-4, Canal Beach, Charlotte County, taken at road into Canal Beach off main road to St. George at covered bridge.

STATION OOBRO1AR0005

LAT. = 45D 10M 15S LONG. = 67D 5M 15S

Description: Gibson Lake outlet, station 1, Charlotte County, taken at bridge on Frye Road.

STATION OOBRO1AR0011

LAT. = 45D 35M 50S LONG. = 67D 19M 35S

Description: Station 6, McAdam, York County, located above treatment plant on inlet to McAdam Lake.

STATION OOBRO1AR0012

LAT. = 45D 37M 5S LONG. = 67D 25M 40S

Description: Little Digdeguash River, station 1, McAdam, York County, taken left side of bridge on Palfrey Lake Lodge Road.

STATION OOBRO1AR0013

LAT. = 45D 19M 45S LONG. = 67D 12M 55S

Description: Oak Bay, station 1, taken 20 m out from middle culvert at small causeway.

STATION OOBRO1AR0014

LAT. = 45D 19M 40S LONG. = 67D 13M 15S

Description: Oak Bay, station 2, Saint David, Charlotte County, taken at inlet to lake.

STATION OOBRO1AR0016

LAT. = 45D 20M 5S LONG. = 67D 13M 45S

Description: Oak Bay, station 4, Saint David, Charlotte County, taken from brook on left side of bay at inlet to lake.

STATION OOBRO1AR0017

LAT. = 45D 20M 10S LONG. = 67D 13M 10S

Description: Oak Bay, station 5, Saint David, Charlotte County, taken at inlet to lake.

STATION OOBRO1AR0018

LAT. = 44D 19M 55S LONG. = 67D 13M 5S

Description: Oak Bay, station 6, Saint David, Charlotte County, taken at centre of bay.

STATION OOBRO1AR0046

LAT. = 45D 35M 0S LONG. = 67D 20M 0S

Description: Station 5, McAdam, York County, taken from inlet to McAdam Lake at road to lake.

STATION OOBRO1BJ0004

LAT. = 47D 58M 25S LONG. = 66D 18M 20S

Description: South Charlo River, station 7, Gloucester County, taken below outfall at fish hatchery.

STATION OOBRO1BQ0002

LAT. = 47D 08M 03S LONG. = 65D 50M 04S

Description: Northwest Miramichi River, Heath Steele at Wayerton bridge.

STATION OOBRO1BQ0006

LAT. = 47D 19M 00S LONG. = 66D 05M 50S

Description: Little Tomogonops, Heath Steele at dam.

STATION OOBRO1BQ0008

LAT. = LONG. =

Description: Tomogonops River above Heath Steele.

STATION OOBRO1BS0001

LAT. = 46D 24M 20S LONG. = 65D 4M 30S

Description: Coal Branch River, station 2, Kent County, taken at Blind Brook at crossing between Clairville and Jailletville.

STATION OOBRO1BS0002

LAT. = 46D 25M 0S LONG. = 65D 4M 25S

Description: Coal Branch River, station 3, Kent County, taken at bridge halfway between Beersville and Clairville.

STATION OOBRO1BS0003

LAT. = 46D 26M 35S LONG. = 65D 3M 55S

Description: Coal Branch River, station 4, Kent County, taken at flow station near Beersville.

STATION OOBRO1BS0005

LAT. = 46D 29M 5S LONG. = 65D 5M 35S

Description: Coal Branch River, station 6, Kent County, taken at covered bridge at Fords Mills.

STATION OOBRO1BU0001

LAT. = 45D 58M 9S LONG. = 64D 30M 41S

Description: Breau Creek at Acadian picnic site access road.

STATION OOBRO1BU0007

LAT. = 46D 4M 20S LONG. = 64D 48M 45S

Description: Petitcodiac River, station 1, Moncton, Westmorland County, taken from NE side of Moncton Causeway.

STATION OOBRO1BU0008

LAT. = 46D 3M 55S LONG. = 64D 48M 25S

Description: Petitcodiac River, station 1 A, Moncton, Westmorland County, taken from SE side of Moncton Causeway.

STATION OOBRO1BU0009

LAT. = 46D 1M 20S LONG. = 65D 2M 5S

Description: Petitcodiac River, station 2, Salisbury, Westmorland County, taken at bridge, Hwy 112 over Petitcodiac River.

STATION OOBRO1BU0013

LAT. = 46D 1M 10S LONG. = 65D 11M 0S

Description: Petitcodiac River, station 6, Westmorland County, taken at bridge over North River between Fawcett and Wheaton Settlement.

STATION OOBRO1BU0014

LAT. = 46D 4M 40S LONG. = 65D 4M 20S

Description: Petitcodiac River, station 7, Westmorland County, taken at bridge over North River upstream from mouth of Blakeney Brook.

STATION OOBRO1BU0015

LAT. = 45D 57M 20S LONG. = 65D 5M 5S

Description: Pollett River, station 1, Westmorland County, taken at bridge upstream from Kay Settlement.

STATION OOBRO1BU0016

LAT. = 45D 54M 25S LONG. = 65D 5M 15S

Description: Pollett River, station 2, Westmorland County, taken from covered bridge downstream from Pollett River.

STATION OOBRO1BU0017

LAT. = 45D 48M 45S LONG. = 65D 6M 25S

Description: Pollett River, station 3, Albert County, taken at covered bridge downstream from Elgin.

STATION 00BRO1BU0018

LAT. = 45D 45M 20S LONG. = 65D 4M 45S

Description: Pollett River, station 4, Albert County, taken at covered bridge by Church Corner.

STATION 00BRO1BU0019

LAT. = 46D 1M 10S LONG. = 65D 1M 25S

Description: Coverdale River, station 1, Albert County, taken at first bridge upstream from the mouth.

STATION 00BRO1BU0024

LAT. = 46D 2M 40S LONG. = 64D 54M 45S

Description: Turtle Creek, station 1, Albert County, taken at covered bridge at mouth.

STATION 00BRO1BU0025

LAT. = 46D 2M 40S LONG. = 64D 52M 45S

Description: Turtle Creek, station 2, Albert County, taken at covered bridge by Turtle Creek.

STATION 00BRO1BU0026

LAT. = 45D 51M 40S LONG. = 64D 51M 35S

Description: Turtle Creek, station 3, Albert County, taken at culvert downstream from fork in road north of Stuart Mountain.

STATION 00BRO1BU0027

LAT. = 46D 5M 55S LONG. = 64D 52M 10S

Description: Jonathan Creek, station 1, Westmorland County, taken at culvert between Berry Mills and Moncton.

STATION 00BRO1BU0028

LAT. = 46D 5M 05S LONG. = 64D 48M 55S

Description: Jonathan Creek, station 2, Moncton, taken at head of Jones Lake.

STATION 00BRO1BU0030

LAT. = 46D 6M 15S LONG. = 64D 47M 45S

Description: Halls Brook, station 2, Moncton, taken off bridge on Connaught Street.

STATION 00BRO1BU0031

LAT. = 46D 6M 40S LONG. = 64D 48M 25S

Description: Halls Brook, station 3, Moncton, taken off bridge on West Lane.

STATION 00BRO1BU0032

LAT. = 46D 7M 15S LONG. = 64D 49M 50S

Description: Halls Brook, station 4, Moncton, taken off bridge on Mapleton.

STATION 00BRO1BU0033

LAT. = 46D 7M 45S LONG. = 64D 51M 45S

Description: Halls Brook, station 5, Moncton, taken at junction of TCH and Hildegard.

STATION 00BRO1BU0036

LAT. = 46D 3M 45S LONG. = 64D 42M 20S

Description: Fox Creek, station 1, Westmorland County, taken from bridge on Route 6 southeast of St-Anselme.

STATION OOBRO1BU0050
LAT. = 46D 6M 35S LONG. = 64D 56M 25S
Description: Jonathan Creek, station 3, Berry Mills, Westmorland County, taken at junction of Route 128 and TCH.

STATION OONB01AD0001
LAT. = 47D 14M 55S LONG. = 68D 36M 20S
Description: Saint John River at Clair at bridge boundary plaque (WSC Gauge).

STATION OONB01AD0005
LAT. = 47D 21M 39S LONG. = 68D 19M 24S
Description: Madawaska River, mouth, Edmundston, Madawaska County.

STATION OONB01AD0008
LAT. = 47D 21M 33S LONG. = 68D 19M 45S
Description: Saint John River at hwy bridge (WSC Gauge), Edmundston.

STATION OONB01AD0012
LAT. = 47D 26M 05S LONG. = 68D 22M 55S
Description: Madawaska River at road bridge at St. Jacques, Madawaska County.

STATION OONB01AD0013
LAT. = 47D 12M 18S LONG. = 68D 56M 21S
Description: St. Francis River above mouth at picnic site, Madawaska County.

STATION OONB01AD0014
LAT. = 47D 21M 21S LONG. = 68D 21M 54S
Description: Saint John River, 200 m above confluence with Ruisseau Deux-Milles (Two Mile Brook), Edmundston.

STATION OONB01AD0015
LAT. = 47D 29M 27S LONG. = 68D 28M 30S
Description: Madawaska River, 9.7 km NW of St. Jacques at Quebec border (left bank).

STATION OONB01AD0016
LAT. = 47D 21M 45S LONG. = 68D 19M 33S
Description: Madawaska River at power plant, tailrace, Edmundston, Madawaska County.

STATION OONB01AF0001
LAT. = 47D 3M 10S LONG. = 67D 44M 25S
Description: Little River at mouth at Grand Falls bridge, Victoria County.

STATION OONB01AF0002
LAT. = 47D 9M 36S LONG. = 67D 55M 51S
Description: Saint John River from centre of international bridge, Saint Leonard, Madawaska County.

STATION OONB01AF0003
LAT. = 46D 57M 36S LONG. = 67D 40M 27S
Description: Salmon River at Hwy 125 bridge, Victoria County.

STATION OONB01AF0005
LAT. = 46D 55M 39S LONG. = 67D 41M 57S
Description: Saint John River at Brooks bridge, near Limestone, Victoria County.

STATION OONB01AF0006

LAT. = 47D 5M 30S LONG. = 67D 43M 48S

Description: Black Brook, 2.6 km SE of St-André-de-Madawaska (WSC Gauge).

STATION OONB01AF0013

LAT. = 47D 10M 0S LONG. = 67D 56M 0S

Description: Grand River at Hwy 2 bridge, 2.6 km north of Saint Leonard, Madawaska County.

STATION OONB01AF0016

LAT. = 47D 18M 24S LONG. = 68D 8M 9S

Description: Green River at TCH bridge, 1.3 km SE of Green River, Madawaska County.

STATION OONB01AF0020

LAT. = 47D 21M 18S LONG. = 68D 14M 3S

Description: Saint John River, 400 m below Ruisseau à Lavoie (Stream) at St. Basile.

STATION OONB01AF0021

LAT. = 47D 20M 6S LONG. = 68D 8M 9S

Description: Green River, 4 km above mouth at bridge (WSC Gauge), Madawaska County.

STATION OONB01AF0022

LAT. = 47D 3M 3S LONG. = 67D 44M 30S

Description: Saint John River in Grand Falls headpond near AWQ monitor, Victoria County.

STATION OONB01AG0001

LAT. = 46D 49D 15S LONG. = 67D 44M 57S

Description: Aroostook River at Hwy 2 bridge, Victoria County.

STATION OONB01AG0002

LAT. = 46D 49M 18S LONG. = 67D 44M 9S

Description: Aroostook River at TCH bridge at Four Falls, Victoria County.

STATION OONB01AG0005

LAT. = 46D 49M 33S LONG. = 67D 44M 21S

Description: Limestone River at picnic site at Four Falls (WSC Gauge), Victoria County.

STATION OONB01AG0008

LAT. = 46D 49M 21S LONG. = 67D 44M 18S

Description: Aroostook River, 10 m above junction with Limestone River, 7 m from left bank, Victoria County.

STATION OONB01AG0009

LAT. = 46D 48M 21S LONG. = 67D 46M 30S

Description: Aroostook River in Tinker headpond at AWQ monitor, Victoria County.

STATION OONB01AH0002

LAT. = 47D 10M 21S LONG. = 67D 12M 27S

Description: Tobique River at Hwy 395 bridge, Riley Brook (WSC Gauge), Victoria County.

STATION OONB01AJ0002

LAT. = 46D 44M 9S LONG. = 67D 42M 36S

Description: Saint John River from centre of hwy bridge, Perth-Andover, Victoria County.

STATION OONB02AJ0006

LAT. = 46D 26M 18S LONG. = 67D 44M 45S

Description: Presquile River at bridge in Tracey Mills, Carleton County.

STATION OONB01AJ0007

LAT. = 46D 12M 57S LONG. = 67D 43M 42S

Description: Meduxnekeag River at Hwy 2 bridge at Woodstock, Carleton County.

STATION OONB01AJ0008

LAT. = 46D 26M 15S LONG. = 67D 44M 42S

Description: Presquile River at Tracey Mills above old dam (WSC Gauge), Carleton County.

STATION OONB01AJ0009

LAT. = 46D 25M 45S LONG. = 67D 37M 15S

Description: Saint John River, 1.5 km south of Florenceville near AWQ monitor, Carleton County.

STATION OONB01AJ0011

LAT. = 46D 27M 30S LONG. = 67D 36M 24S

Description: Saint John River above McCains, 2.6 km NE of Florenceville (WSC Gauge), Carleton County.

STATION OONB01AJ0012

LAT. = 46D 27M 05S LONG. = 67D 47M 6S

Description: Big Presque Isle Stream, 100 m east of international border near intake of AWQ monitor, Carleton County.

STATION OONB01AJ0013

LAT. = 46D 17M 51S LONG. = 67D 31M 54S

Description: Saint John River at centre of covered bridge at Hartland, Carleton County.

STATION OONB01AJ0014

LAT. = 46D 9M 54S LONG. = 67D 34M 12S

Description: Saint John River at Grafton bridge at Woodstock (WSC Gauge), Carleton County.

STATION OONB01AJ0015

LAT. = 46D 12M 05S LONG. = 67D 42M 05S

Description: Meduxnekeag River at Belleville near intake of AWQ monitor, Carleton County.

STATION OONB01AJ0016

LAT. = 46D 36M 48S LONG. = 67D 36M 39S

Description: Holmes Brook at Moose Mountain (WSC Gauge), Carleton County.

STATION OONB01AJ0017

LAT. = 46D 34M 33S LONG. = 67D 35M 42S

Description: Holmes Brook at Holmesville (WSC Gauge), Carleton County.

STATION OONB01AJ0026

LAT. = 46D 25M 36S LONG. = 67D 42M 36S

Description: Presquile River at Hwy 560 bridge, Centreville, Carleton County.

STATION OONB01AJ0027

LAT. = 46D 28M 9S LONG. = 67D 35M 9S

Description: Saint John River, 600 m below junction with Little Shikatehawk River, Bristol, Carleton County.

STATION OONB01AJ0028

LAT. = 46D 26M 30S LONG. = 67D 37M 15S

Description: Saint John River at Hwy 110 bridge, Florenceville, Carleton County.

STATION OONB01AJ0029

LAT. = 46D 11M 57S LONG. = 67D 42M 0S

Description: Meduxnekeag River at bridge above junction with Mill Stream, Belleville, Carleton County.

STATION OONB01AJ0030

LAT. = 46D 32M 36S LONG. = 67D 40M 12S

Description: Saint John River in Beechwood headpond at power dam near AMQ monitor, Carleton County.

STATION OONB01AK0001

LAT. = 45D 57M 40S LONG. = 66D 49M 10S

Description: Saint John River, east side landing of former McKinley Ferry (WSC Gauge), York County.

STATION OONB01AK0002

LAT. = 46D 1M 36S LONG. = 66D 42M 0S

Description: North Nashwaaksis Stream at Hwy 620 bridge (Royal Road) (WSC Gauge), York County.

STATION OONB01AK0003

LAT. = 46D 4M 57S LONG. = 66D 44M 3S

Description: North Nashwaaksis Stream at Hwy 620 bridge on Sandwith farm (WSC Gauge), York County.

STATION OONB01AK0017

LAT. = 45D 57M 25S LONG. = 67D 19M 55S

Description: Shogomoc Stream, north side of the bridge (WSC Gauge), York County.

STATION OONB01AK0018

LAT. = 45D 52M 54S LONG. = 67D 1M 15S

Description: Waterloo Lake, outlet into Saint John River, LGA-2, York County.

STATION OONB01AK0019

LAT. = 45D 50M 6S LONG. = 67D 4M 27S

Description: LGA-3, Pokiok Stream above Route 635 hwy bridge at outlet of Lake George.

STATION OONB01AK0020

LAT. = 45D 57M 33S LONG. = 67D 14M 54S

Description: Pokiok Stream, mouth at TCH bridge, LGA-4, York County.

STATION OONB01AK0028

LAT. = 45D 54M 3S LONG. = 67D 1M 30S

Description: Jocelyne Brook 2.5 km NW of Lower Prince William, at TCH bridge, York County.

STATION OONB01AK0029

LAT. = 45D 50M 6S LONG. = 67D 4M 21S

Description: Pokiok Stream at outlet of Lake George near Magundy, York County.

STATION OONB01AK0030

LAT. = 45D 56M 39S LONG. = 66D 37M 39S

Description: Saint John River at TCH bridge below Fredericton, York County.

STATION OONB01AL0003

LAT. = 46D 7M 35S LONG. = 66D 36M 45S

Description: Nashwaak River at Durham Bridge (WSC Gauge), York County.

STATION OONB01AL0006

LAT. = 46D 14M 24S LONG. = 66D 36M 45S

Description: Nashwaak River at bridge in Nashwaak Bridge, York County.

STATION OONB01AL0007

LAT. = 45D 57M 18S LONG. = 66D 37M 24S

Description: Nashwaak River at CPR bridge, Barkers Point, York County.

STATION OONB01AL0008

LAT. = 46D 8M 42S LONG. = 66D 37M 15S

Description: Dunbar Stream below falls, 400 m from confluence with Nashwaak River.

STATION OONB01AM0001

LAT. = 45D 40M 30S LONG. = 66D 41M 0S

Description: North Branch Oromocto River at Tracy (WSC Gauge), Sunbury County.

STATION OONB01AM0003

LAT. = 45D 50M 54S LONG. = 66D 31M 6S

Description: Oromocto River at Hwy 7 bridge, Oromocto, Sunbury County.

STATION OONB01AN0001

LAT. = 46D 13M 48S LONG. = 65D 50M 48S

Description: Salmon River at Hwy 123 bridge, Gaspereau Forks, Queens County.

STATION OONB01AN0002

LAT. = 46D 9M 15S LONG. = 65D 57M 6S

Description: Iron Bound Cove Stream at upper hwy bridge, Queens County.

STATION OONB01AN0003

LAT. = 46D 8M 30S LONG. = 65D 57M 3S

Description: Iron Bound Cove Stream at lower causeway, Sunbury County.

STATION OONB01AN0005

LAT. = 46D 10M 33S LONG. = 65D 53M 6S

Description: Salmon River from Hwy 10 bridge at Chipman, Queens County.

STATION OONB01AN0007

LAT. = 46D 10M 33S LONG. = 65D 57M 0S

Description: Coal wash influent from Iron Bound Cove Stream, 180 m above coal wash plant below CNR bridge, Queens County.

STATION OONB01AM0010

LAT. = 46D 6M 12S LONG. = 65D 55M 30S

Description: Salmon River, mouth at former O'Leary ferry crossing, Queens County.

STATION OONB01A00001

LAT. = 46D 0M 51S LONG. = 66D 12M 45S

Description: Little River at Hwy 10 bridge, 1.5 km north of Ripples, Sunbury County.

STATION OONB01A00002

LAT. = 46D 4M 39S LONG. = 66D 3M 21S

Description: Newcastle Creek, east of Minto, Queens County.

STATION OONB01A00003

LAT. = 45D 49M 45S LONG. = 66D 7M 0S

Description: Jamseg River at old bridge abutment (WSC Gauge), Jamseg, Queens County.

STATION OONB01A00004

LAT. = 45D 51M 57S LONG. = 66D 27M 0S

Description: Saint John River at Burton bridge (WSC Gauge), Maugerville, Sunbury County.

STATION OONB01A00008

LAT. = 46D 4M 21S LONG. = 66D 0M 24S

Description: Newcastle Creek at causeway about 5 km east of Minto (WSC Gauge), Queens County.

STATION OONB01A00009

LAT. = 45D 56M 48S LONG. = 66D 4M 18S

Description: Drainage from The Keyhole into Grand Lake at hwy bridge, Princess Park, Queens County.

STATION OONB01A00010

LAT. = 46D 5M 36S LONG. = 65D 52M 51S

Description: Coal Creek at Hwy 10 bridge, Pennlyn Station, Queens County.

STATION OONB01A00011

LAT. = 45D 54M 6S LONG. = 66D 15M 27S

Description: Unnamed stream between French Lake and Maquapit Lake at hwy bridge, Sunbury County.

STATION OONB01A00012

LAT. = 45D 49M 18S LONG. = 66D 7M 3S

Description: Jemseg River at old hwy bridge, Jemseg, Queens County.

STATION OONB01A00015

LAT. = 46D 2M 24S LONG. = 65D 51M 54S

Description: Cumberland Bay Stream at Hwy 10 bridge, Cumberland Bay, Queens County.

STATION OONB01AP0001

LAT. = 46D 4M 18S LONG. = 65D 22M 0S

Description: Canaan River at Hwy 112 bridge (WSC Gauge), East Canaan, Queens County.

STATION OONB01AP0002

LAT. = 45D 42M 5S LONG. = 65D 36M 10S

Description: Kennebecasis River at Hwy 880 bridge, Apohaqui, Kings County.

STATION OONB01AP0007

LAT. = 45D 17M 51S LONG. = 66D 0M 33S

Description: Little River at Silver Falls, Saint John County.

STATION OONB01AP0012

LAT. = 45D 16M 05 LONG. = 66D 4M 15S

Description: Saint John Harbour on eastern side of harbour at end of N.H.B. pier.

STATION OONB01AP0013

LAT. = 45D 41M 05 LONG. = 65D 33M 36S

Description: Cove Brook, about 3.25 km upstream from mouth, Kings County.

STATION OONB01AP0014

LAT. = 45D 41M 15S LONG. = 65D 33M 39S

Description: Cove Brook, about 2.88 km upstream from mouth, Kings County.

STATION OONB01AP0021

LAT. = 45D 42M 21S LONG. = 66D 10M 39S

Description: Otnabog River at Hwy 102 bridge, about 5 km NW of Queenstown, Queens County.

STATION OONB01AP0030

LAT. = 45D 48M 27S LONG. = 65D 18M 05

Description: Kennebecasis River at TCH bridge, 19.2 km east of Sussex, Kings County.

STATION OONB01AP0031

LAT. = 45D 47M 35 LONG. = 65D 21M 36S

Description: Kennebecasis River at Poultry Farm Road, 1.28 km west of Crockets Corner, Kings County.

STATION OONB02AP0032

LAT. = 45D 44M 39S LONG. = 65D 29M 54S

Description: Kennebecasis River at covered bridge, about 2.4 km NE of Sussex, Kings County.

STATION OONB01AP0033

LAT. = 45D 23M 51S LONG. = 66D 17M 18S

Description: Nerepis River at hwy bridge, Nerepis, Kings County.

STATION OONB01AP0034

LAT. = 45D 32M 36S LONG. = 65D 50M 35

Description: Kennebecasis River at bridge, Hampton, Kings County.

STATION OONB01AP0035

LAT. = 45D 10M 12S LONG. = 66D 28M 6S

Description: Lepreau River at Hwy 1 bridge, Lepreau (WSC Gauge), Charlotte County.

STATION OONB01AQ0010

LAT. = 45D 29M 51S LONG. = 66D 53M 57S

Description: Piskahegan River at bridge, 3 km above confluence with Niles Brook, MP-1, Charlotte County.

STATION OONB01AQ0011

LAT. = 45D 25M 9S LONG. = 66D 53M 12S

Description: Piskahegan River at bridge, 3 km below confluence with Hatch Brook, MP-2, Charlotte County.

STATION OONB01AQ0012

LAT. = 45D 23M 48S LONG. = 66D 55M 15S

Description: Magaguadavic River at Pomeroy Bridge, 1.75 km above Piskahegan River, MP-3, Charlotte County.

STATION OONB01AQ0013

LAT. = 45D 21M 39S LONG. = 66D 53M 24S

Description: Magaguadavic River, 2.75 km below Piskahegan River at Little Falls, MP-4, Charlotte County.

STATION OONB01AQ0014

LAT. = 45D 18M 51S LONG. = 66D 51M 0S

Description: Magaguadavic River, 1 km upstream from Lake Stream, MP-5, Charlotte County.

STATION OONB01AQ0015

LAT. = 45D 22M 36S LONG. = 66D 50M 39S

Description: Lower Niles Brook, downstream from road, MP-6, Charlotte County.

STATION OONB01AQ0016

LAT. = 45D 26M 9S LONG. = 66D 51M 3S

Description: Hatch Brook at bridge, 2.3 km above Piskahegan River, Charlotte County.

STATION OONB01AQ0017

LAT. = 45D 10M 10S LONG. = 67D 17M 50S

Description: St. Croix River at international bridge, Milltown, Charlotte County.

STATION OONB01AR0002

LAT. = 45D 11M 39S LONG. = 67D 35M 45S

Description: St. Croix River at international bridge (WSC Gauge), York County.

STATION OONB01AR0003

LAT. = 45D 11M 39S LONG. = 67D 0M 0S

Description: Bocabec River at old sawmill, 1.6 km above Hwy 1 bridge (WSC Gauge), Charlotte County.

STATION OONB01AR0005

LAT. = LONG. =

Description: Bocabec River below Johnson Lake.

STATION OONB01AR0006

LAT. = LONG. =

Description: Stream from Mud Lake to Bocabec River.

STATION OONB01AR0007

LAT. = 45D 12M 25S LONG. = 67D 1M 10S

Description: Bocabec River at outlet of Kerr Lake (WSC Gauge), Charlotte County.

STATION OONB01AR0008

LAT. = 45D 9M 25S LONG. = 67D 5M 45S

Description: Chamcook Stream at Little Chamcook Lake outlet (WSC Gauge), Charlotte County.

STATION OONB01AR0009

LAT. = 45D 12M 36S LONG. = 67D 15M 45S

Description: Dennis Stream at Hwy 1 bridge (WSC Gauge), Saint Stephen, Charlotte County.

STATION OONB01AR0010

LAT. = 45D 18M 45S LONG. = 67D 4M 20S

Description: Digdeguash River at Rolling Dam, Charlotte County.

STATION OONB01AR0011

LAT. = 45D 39M 45S LONG. = 67D 43M 42S

Description: Grand Lake outlet at Hwy 122 bridge, Forest City, York County.

STATION OONB01BA0001

LAT. = 47D 40M 0S LONG. = 67D 29M 30S

Description: Restigouche River at Montgomery Bridge above confluence with Kedgwick River (WSC Gauge).

STATION OONB01BB0007

LAT. = 47D 39M 55S LONG. = 67D 29M 30S

Description: Kedgwick River at confluence with Restigouche River, Restigouche County.

STATION OONB01BC0001

LAT. = 47D 40M 0S LONG. = 67D 29M 30S

Description: Restigouche River at hwy bridge below Kedgwick River (WSC Gauge), Restigouche County.

STATION OONB01BE0001

LAT. = 47D 49M 57S LONG. = 66D 53M 12S

Description: Upsalquitch River at railroad bridge (WSC Gauge), Upsalquitch, Restigouche County.

STATION OONB01BE0002

LAT. = 47D 29M 30S LONG. = 61D 30M 0S

Description: Unnamed river, north inlet to Upsalquitch Lake, Restigouche County.

STATION OONB01BE0003

LAT. = 47D 29M 33S LONG. = 66D 31M 3S

Description: Drainage to Upsalquitch Lake below mine property R2, Restigouche County.

STATION OONB01BE0013

LAT. = 47D 38M 54S LONG. = 66D 58M 36S

Description: Burntland Brook at confluence with Northwest Upsalquitch River, CMC-1, Restigouche County.

STATION OONB01BE0014

LAT. = 47D 38M 51S LONG. = 66D 58M 51S

Description: Northwest Upsalquitch River, about 100 m above Burntland Brook, CMC-2, Restigouche County.

STATION OONB01BE0015

LAT. = 47D 38M 54S LONG. = 66D 58M 3S

Description: Northwest Upsalquitch River, about 600 m below Burntland Brook, CMC-3, Restigouche County.

STATION OONB01BE0016

LAT. = 47D 46M 36S LONG. = 66D 53M 42S

Description: Boland Brook, mouth at Upsalquitch River, CMC-4, Restigouche County.

STATION OONB01BE0017

LAT. = 47D 46M 3S LONG. = 66D 53M 9S

Description: Upsalquitch River, 1.2 km above Boland Brook, CMC-5, Restigouche County.

STATION OONB01BE0018

LAT. = 47D 47M 3S LONG. = 66D 53M 33S

Description: Upsalquitch River, 750 m below Boland Brook, CMC-6, Restigouche County.

STATION OONB01BE0019

LAT. = 47D 53M 27S LONG. = 66D 56M 54S

Description: Upsalquitch River at bridge, Robinsonville, CMC-7, Restigouche County.

STATION OONB01BJ0008

LAT. = 47D 31M 9S LONG. = 65D 48M 24S

Description: South Little River at Theriault Road bridge, B #12-6, Gloucester County.

STATION OONB01BJ0009

LAT. = 47D 31M 9S LONG. = 65D 48M 24S

Description: South Little River at Theriault Road bridge (WSC Gauge), Gloucester County.

STATION OONB01BJ0010

LAT. = 47D 34M 3S LONG. = 65D 42M 9S

Description: Little River, about 6.4 km SW of Bathurst (WSC Gauge), at Carroll's farm, Gloucester County.

STATION OONB01BJ0013

LAT. = 47D 43M 54S LONG. = 65D 45M 30S

Description: Nigadoo River, 1.6 km below mine at bridge at Tremblay Settlement, NIG-4, Gloucester County.

STATION OONB01BJ0028

LAT. = 47D 38M 57S LONG. = 65D 41M 45S

Description: Tetagouche River, 500 m below bridge on Tetagouche North Road (WSC Gauge), Gloucester County.

STATION OONB01BJ0029

LAT. = 47D 53M 48S LONG. = 66D 1M 42S

Description: Jacquet River, about 3.2 km above mouth (WSC Gauge), Durham Centre, Restigouche County.

STATION OONB01BJ0030

LAT. = 48D 1M 30S LONG. = 66D 22M 36S

Description: Eel River at headpond near pumping station intake, Restigouche County.

STATION OONB01BJ0031

LAT. = 47D 42M 18S LONG. = 65D 44M 54S

Description: Beresford, below mine, M-1, Beresford, Gloucester County.

STATION OONB01BJ0032

LAT. = 47D 40M 45S LONG. = 65D 54M 0S

Description: Millstream River at bridge, 2 km south of Nicholas Denys, M-2, Gloucester County.

STATION OONB01BJ0033

LAT. = 47D 40M 0S LONG. = 65D 58M 0S

Description: Millstream River at mine campsite above mine operations, M-3, Gloucester County.

STATION OONB01BJ0034

LAT. = 47D 48M 21S LONG. = 65D 48M 57S

Description: Elmtree River above mine site at bridge on Main Road, K-1, Gloucester County.

STATION OONB01BJ0035

LAT. = 47D 48M 21S LONG. = 65D 48M 36S

Description: Elmtree River at washed-out bridge below mine concentrator site, K-2, Gloucester County.

STATION OONB01BJ0036

LAT. = 47D 48M 15S LONG. = 65D 48M 39S

Description: Elmtree River above tailings impoundment, K-3, Gloucester County.

STATION OONB01BJ0037

LAT. = 47D 48M 18S LONG. = 65D 48M 36S

Description: Elmtree River below tailings pond at small bridge, K-4, Gloucester County.

STATION OONB01BJ0051

LAT. = 47D 31M 27S LONG. = 65D 47M 54S

Description: Little River, about 100 m below confluence with South Little River, Gloucester County.

STATION OONB01BJ0052

LAT. = 47D 48M 30S LONG. = 65D 45M 0S

Description: Elmtree River, 200 m above railroad bridge, Petit Rocher Nord, Gloucester County.

STATION OONB01BJ0054

LAT. = 47D 58M 36S LONG. = 66D 55M 42S

Description: Restigouche River at hwy bridge at Matapédia, Restigouche County.

STATION OONB01BJ0055

LAT. = 47D 58M 27S LONG. = 66D 56M 45S

Description: Matapédia River at Matapédia from bridge, Bonaventure County, Que.

STATION OONB01BJ0056

LAT. = 47D 54M 30S LONG. = 66D 56M 51S

Description: Restigouche River at Rafting Ground Brook (WSC Gauge).

STATION OONB01BK0003

LAT. = 47D 24M 12S LONG. = 65D 45M 42S

Description: Knight Brook at confluence with Nepisiguit River, Gloucester County.

STATION OONB01BK0004

LAT. = 47D 24M 15S LONG. = 65D 46M 12S

Description: Nepisiguit River, 500 m above Knight Brook, B #6-5, Gloucester County.

STATION OONB01BK0006

LAT. = 47D 23M 51S LONG. = 65D 49M 9S

Description: Austin Brook at confluence with Nepisiguit River, Gloucester County.

STATION OONB01BK0007

LAT. = 47D 23M 45S LONG. = 65D 49M 21S

Description: Nepisiguit River, 300 m above confluence with Austin Brook, Bathurst Mines, Gloucester County.

STATION OONB01BK0008

LAT. = 47D 23M 57S LONG. = 65D 44M 0S

Description: Nepisiguit River, about 2.3 km below Knight Brook, B #6-9, Gloucester County.

STATION OONB01BK0009

LAT. = 47D 24M 39S LONG. = 65D 43M 9S

Description: Nepisiguit River, 4.8 km below Knight Brook, B #6-10, Gloucester County.

STATION OONB01BK0012

LAT. = 47D 34M 9S LONG. = 66D 18M 3S

Description: Forty Mile Brook at pumpsite, 800 m above Anaconda Brass Mine property, AB-1, Northumberland County.

STATION OONB01BK0013

LAT. = 47D 34M 12S LONG. = 66D 17M 39S

Description: Forty Mile Brook at new bridge culvert below ADIT, AB-2, Northumberland County.

STATION OONB01BK0014

LAT. = 47D 34M 3S LONG. = 66D 17M 6S

Description: Forty Mile Brook at reservoir spillway discharge below ADIT, AB-3, Northumberland County.

STATION OONB01BK0015

LAT. = 47D 23M 39S LONG. = 66D 7M 15S

Description: Forty Mile Brook just above confluence with Nepisiguit River, Northumberland County.

STATION OONB01BK0017

LAT. = 47D 23M 39S LONG. = 66D 8M 15S

Description: Nepisiguit River, 1.3 km above Forty Mile Brook above Wedge Mine, W-1, Northumberland County.

STATION OONB01BK0020

LAT. = 47D 23M 33S LONG. = 66D 4M 24S

Description: Nepisiguit River, 4 km below Forty Mile Brook at Hwy 430 bridge, Northumberland County.

STATION OONB01BK0025

LAT. = 47D 23M 57S LONG. = 65D 48M 9S

Description: Nepisiguit River, midway between Austin Brook and dam, B #6-2, Gloucester County.

STATION OONB01BK0026

LAT. = 47D 26M 27S LONG. = 65D 42M 21S

Description: Nepisiguit River at Hwy 360 bridge near NLU Mine, B #6-13, Gloucester County.

STATION OONB01BK0027

LAT. = 47D 30M 27S LONG. = 65D 40M 39S

Description: Nepisiguit River at Pabineau Falls, B #6-14 (WSC Gauge), Gloucester County.

STATION OONB01BK0028

LAT. = 47D 32M 18S LONG. = 65D 40M 05

Description: Nepisiguit River, 1 km below Pabineau River, Pabineau Indian Reserve, B #6-15, Gloucester County.

STATION OONB01BK0029

LAT. = 47D 36M 39S LONG. = 65D 38M 24S

Description: Nepisiguit River above Bathurst at water pump station, B #6-17, Gloucester County.

STATION OONB01BK0030

LAT. = 47D 36M 51S LONG. = 65D 38M 24S

Description: Nepisiguit River at Bathurst at Irving pier below Hwy 11 bridge, Gloucester County.

STATION OONB01BK0031

LAT. = 47D 37M 6S LONG. = 65D 38M 45S

Description: Nepisiguit River opposite Irving pier below pulp mill, B #6-18, Gloucester County.

STATION OONB01BK0032

LAT. = 47D 23M 33S LONG. = 66D 7M 18S

Description: Nepisiguit River just above confluence of Forty Mile Brook, Northumberland County.

STATION OONB01BK0034

LAT. = 47D 24M 21S LONG. = 66D 30M 48S

Description: Portage Brook, 250 m above mouth at bridge, Popple Depot, R-5, Northumberland County.

STATION OONB01BK0035

LAT. = 47D 24M 6S LONG. = 66D 31M 21S

Description: Nepisiguit River, 400 m above confluence with Portage Brook, R-6, Northumberland County.

STATION OONB01BK0036

LAT. = 47D 28M 39S LONG. = 66D 35M 42S

Description: Portage Brook (head) below mine property, R-4, Restigouche County.

STATION OONB01BK0037

LAT. = 47D 24M 0S LONG. = 65D 51M 0S

Description: Austin Brook above sump pump outflow, B #6-1D, Gloucester County.

STATION OONB01BK0039

LAT. = 47D 30M 0S LONG. = 66D 33M 0S

Description: Drainage to Upsalquitch Lake above mine property, R-1, Restigouche County.

STATION OONBO1BK0040

LAT. = 47D 23M 48S LONG. = 66D 30M 39S

Description: Nepisiguit River below Portage Brook at Popple Depot, R-7, Northumberland County.

STATION OONBO1BK0041

LAT. = 47D 26M 0S LONG. = 65D 42M 0S

Description: Nepisiguit River, true right bank, below Gordon Meadow Brook, above NLU-2, Gloucester County.

STATION OONBO1BK0050

LAT. = 47D 24M 9S LONG. = 65D 45M 39S

Description: Nepisiguit River, about 50 m below confluence with Knight Brook, Gloucester County.

STATION OONBO1BL0001

LAT. = 47D 42M 21S LONG. = 65D 9M 18S

Description: Southwest Caraguet River at bridge (WSC Gauge), Burnsville, Gloucester County.

STATION OONBO1BL0002

LAT. = 47D 26M 6S LONG. = 65D 6M 24S

Description: Tracadie River at Murchy Bridge crossing (WSC Gauge), Gloucester County.

STATION OONBO1BL0003

LAT. = 46D 33M 0S LONG. = 65D 6M 40S

Description: Bass River in Gloucester County.

STATION OONBO1BL0004

LAT. = 47D 20M 51S LONG. = 65D 26M 0S

Description: Tabusintac River at Hwy 8 bridge, Jeanne Mance, Gloucester County.

STATION OONBO1BL0032

LAT. = 47D 20M 15S LONG. = 65D 6M 18S

Description: Tabusintac River at bridge, south side of Cain Point, Northumberland County.

STATION OONBO1BM0001

LAT. = 46D 28M 57S LONG. = 66D 28M 54S

Description: Southwest Miramichi River at bridge, Bloomfield Ridge, Northumberland County.

STATION OONBO1BM0002

LAT. = 46D 33M 24S LONG. = 66D 49M 54S

Description: Southwest Miramichi River, 2.4 km above Burnthill Brook, at warden's camp, BT-1, York County.

STATION OONBO1BM0003

LAT. = 46D 34M 21S LONG. = 66D 47M 39S

Description: Southwest Miramichi River, 1 km below Burnthill Brook, York County.

STATION OONBO1BM0004

LAT. = 47D 36M 0S LONG. = 66D 41M 30S

Description: Southwest Miramichi River, left bank at Rocky Bend Rapids, about 8 km below mine area, BT-5, York County.

STATION OONB01BN0001

LAT. = 46D 39M 54S LONG. = 65D 46M 33S

Description: Cains River at confluence with Southwest Miramichi River at bridge, Northumberland County.

STATION OONB01B00001

LAT. = 46D 44M 9S LONG. = 65D 49M 36S

Description: Southwest Miramichi River at bridge (WSC Gauge), Blackville, Northumberland County.

STATION OONB01B00002

LAT. = 46D 49M 18S LONG. = 66D 6M 51S

Description: Renous River, 300 m above confluence of McGraw Brook (WSC Gauge), Northumberland County.

STATION OONB01B00007

LAT. = 46D 53M 10S LONG. = 65D 31M 5S

Description: Barnaby River at Barnaby River, Northumberland County.

STATION OONB01B00013

LAT. = 46D 48M 45S LONG. = 65D 47M 45S

Description: Renous River at Hwy 8 bridge, Northumberland County.

STATION OONB01B00015

LAT. = LONG. =

Description: Southwest Miramichi River at White Rapids.

STATION OONB01B00019

LAT. = 47D 11M 21S LONG. = 65D 24M 24S

Description: Bartibog River at Hwy 8 bridge, Bartibog, Northumberland County.

STATION OONB01B00001

LAT. = 46D 56M 6S LONG. = 65D 54M 30S

Description: Little Southwest Miramichi River at bridge, Lyttleton (WSC Gauge), Northumberland County.

STATION OONB01BQ0001

LAT. = 46D 56M 39S LONG. = 65D 49M 21S

Description: Northwest Miramichi River at Redbank-Sunny Corner bridge, Northumberland County.

STATION OONB01BQ0004

LAT. = 47D 17M 36S LONG. = 66D 2M 3S

Description: South Tomogonops River below tailings pond at Hwy 430 bridge, H-3, Northumberland County.

STATION OONB01BQ0008

LAT. = 47D 2M 54S LONG. = 65D 50M 21S

Description: Sevogle River at confluence with Northwest Miramichi River, Curventon, Northumberland County.

STATION OONB01BQ0013

LAT. = 47D 18M 30S LONG. = 66D 4M 57S

Description: Little South Tomogonops River above mine property, H-12, Northumberland County.

STATION 00NB01BQ0017

LAT. = 47D 17M 21S LONG. = 66D 1M 39S

Description: Little South Tomogonops River, 3 km above Tomogonops River, H-16 (O'Briens), Northumberland County.

STATION 00NB01BQ0018

LAT. = 47D 13M 57S LONG. = 65D 50M 6S

Description: Tomogonops River at confluence with Northwest Miramichi River, 14.5 km above Wayerton Bridge, Northumberland County.

STATION 00NB01BQ0019

LAT. = 47D 13M 57S LONG. = 65D 50M 9S

Description: Northwest Miramichi River just above junction with Tomogonops River, H-18, Northumberland County.

STATION 00NB01BQ0020

LAT. = 47D 6M 36S LONG. = 66D 14M 9S

Description: Clearwater Stream at bridge, 300 m above Chester mine property, C-1, Northumberland County.

STATION 00NB01BQ0021

LAT. = 47D 4M 45S LONG. = 66D 12M 54S

Description: Clearwater Stream, 800 m below mine, 4 km above South Sevogle River, C-2, Northumberland County.

STATION 00NB01BQ0023

LAT. = 47D 8M 27S LONG. = 66D 12M 48S

Description: Sheephouse Brook at bridge above mine property, C-4, Northumberland County.

STATION 00NB01BQ0024

LAT. = 47D 6M 24S LONG. = 66D 10M 36S

Description: Sheephouse Brook below mine property, C-5, Northumberland County.

STATION 00NB01BQ0025

LAT. = 47D 18M 51S LONG. = 66D 21M 9S

Description: Northwest Miramichi River above mine, T-1, Northumberland County.

STATION 00NB01BQ0026

LAT. = 47D 16M 42S LONG. = 66D 19M 30S

Description: Northwest Miramichi River, 1 km above junction with South Branch Northwest Miramichi River, T-2, Northumberland County.

STATION 00NB01BQ0029

LAT. = 47D 3M 15S LONG. = 66D 10M 54S

Description: South River above confluence with Clearwater Stream, C-6, Northumberland County.

STATION 00NB01BQ0030

LAT. = 47D 3M 36S LONG. = 66D 5M 6S

Description: South Sevogle River between Clearwater Stream and Sheephouse Brook, C-7, Northumberland County.

STATION OONB01BQ0031

LAT. = 47D 4M 39S LONG. = 65D 59M 0S

Description: South Sevogle River below confluence with Sheephouse Brook, C-8, Northumberland County.

STATION OONB01BQ0035

LAT. = 47D 26M 18S LONG. = 65D 53M 54S

Description: Heath Steele Mine Station H-19, Northwest Miramichi River at Payne (Miner's) Bridge, Northumberland County.

STATION OONB01BQ0037

LAT. = 47D 18M 21S LONG. = 66D 21M 0S

Description: Unnamed stream entering Northwest Miramichi River at trout pool, T-3, Northumberland County.

STATION OONB01BQ0038

LAT. = 47D 17M 21S LONG. = 66D 19M 27S

Description: Brook at bridge above Northwest Miramichi River, T-4, Northumberland County.

STATION OONB01BQ0039

LAT. = 47D 17M 30S LONG. = 66D 4M 0S

Description: Brook at road to mill, Heath Steele, H-8, Northumberland County.

STATION OONB01BQ0040

LAT. = 47D 18M 0S LONG. = 66D 4M 30S

Description: Little South Tomogonops above clean water channel, Heath Steele, H-11, Northumberland County.

STATION OONB01BQ0041

LAT. = 47D 18M 20S LONG. = 66D 2M 35S

Description: Little South Tomogonops above clean water channel, H-13, Northumberland County.

STATION OONB01BQ0043

LAT. = 47D 11M 25S LONG. = 65D 54M 30S

Description: Little River, 1.3 km above junction with Northwest Miramichi River, H-20, Northumberland County.

STATION OONB01BQ0044

LAT. = 47D 8M 6S LONG. = 65D 50M 6S

Description: Northwest Miramichi River at Wayerton bridge, N-21, Northumberland County.

STATION OONB01BQ0045

LAT. = 47D 19M 39S LONG. = 66D 4M 9S

Description: North Branch Tomogonops River at water supply dam by Hwy 430, H-22 (Control), Northumberland County.

STATION OONB01BQ0053

LAT. = 47D 3M 39S LONG. = 65D 49M 54S

Description: Northwest Miramichi River mine water monitoring station at Curventon fence, Northumberland County.

STATION OONB01BQ0054

LAT. = 47D 4M 6S LONG. = 66D 15M 30S

Description: South Sevogle River at bridge, 6 km above junction with Clearwater Stream, Northumberland County.

STATION OONB01BQ0055

LAT. = 47D 3M 48S LONG. = 66D 1M 15S

Description: South Sevogle River, about 3 km above confluence of Sheephouse Brook, Northumberland County.

STATION OONB01BQ0056

LAT. = 47D 11M 15S LONG. = 65D 53M 36S

Description: Northwest Miramichi River at Hwy 430 bridge, Northumberland County.

STATION OONB01BR0001

LAT. = 46D 44M 40S LONG. = 65D 12M 20S

Description: Kouchibouguac River at Vautour (WSC Gauge), Kent County.

STATION OONB01BR0011

LAT. = 46D 47M 33S LONG. = 65D 3M 15S

Description: Kouchibouguac River at Hwy 11 at Kouchibouguac, Kent County.

STATION OONB01BS0001

LAT. = 46D 26M 35S LONG. = 65D 3M 55S

Description: Coal Branch River at Beersville (WSC Gauge), Kent County.

STATION OONB01BS0003

LAT. = 46D 33M 0S LONG. = 65D 6M 42S

Description: Bass River at Hwy 116 bridge, about 700 m north of Bass River, Kent County.

STATION OONB01BS0004

LAT. = 46D 34M 54S LONG. = 65D 4M 33S

Description: Molus River at Hwy 116 bridge, 600 m north of Molus River, Kent County.

STATION OONB01BS0018

LAT. = 46D 22M 15S LONG. = 64D 52M 33S

Description: Buctouche River at bridge in Coates Mills, Kent County.

STATION OONB01BS0019

LAT. = 46D 18M 54S LONG. = 64D 43M 45S

Description: Cocagne River at Hwy 525 bridge, Notre-Dame, Kent County.

STATION OONB01BS0046

LAT. = 46D 31M 24S LONG. = 65D 5M 24S

Description: Richibucto River at Hwy 116 bridge, Smiths Corner, Kent County.

STATION OONB01BU0001

LAT. = 45D 53M 15S LONG. = 64D 31M 0S

Description: Palmers Creek near Dorchester (WSC Gauge), Westmorland County.

STATION OONB01BU0004

LAT. = 46D 3M 57S LONG. = 64D 48M 27S

Description: Petitcodiac River at control gates of Moncton Riverview causeway, Westmorland County.

STATION OONB01BU0005

LAT. = 46D 1M 20S

LONG. = 65D 2M 5S

Description: Petitcodiac River at Hwy 112 bridge, Salisbury, Westmorland County.

STATION OONB01BU0006

LAT. = 45D 57M 33S

LONG. = 64D 52M 42S

Description: Turtle Creek at inlet to Turtle Creek reservoir (WSC Gauge), Westmorland County.

STATION OONB01BU0008

LAT. = 46D 4M 0S

LONG. = 64D 34M 20S

Description: Memramcook River at Calhoun, Westmorland County.

STATION OONB02BU0031

LAT. = 45D 56M 36S

LONG. = 65D 10M 12S

Description: Petitcodiac River from Hwy 2 bridge north of Petitcodiac (WSC Gauge), Westmorland County.

STATION OONB01BU0051

LAT. = 46D 0M 3S

LONG. = 64D 53M 39S

Description: Turtle Creek at reservoir intake at pumphouse, Albert County.

STATION OONB01BV0003

LAT. = 45D 25M 21S

LONG. = 65D 24M 36S

Description: Big Salmon River at counting fence, 12.7 km NE of St. Martins (WSC Gauge), Saint John County.

STATION OONB01BV0004

LAT. = 45D 36M 36S

LONG. = 64D 57M 36S

Description: Upper Salmon (Alma) River at intake in river at Kinnie Brook near WSC Gauge, Albert County.

STATION OONB01BV0005

LAT. = 45D 33M 15S

LONG. = 65D 0M 54S

Description: Point Wolf River at intake in river, 456 m above road bridge, Albert County.

STATION OONB01BV0006

LAT. = 45D 34M 27S

LONG. = 65D 4M 39S

Description: Tributary of Point Wolf River at Chambers Lake at road, Albert County.

STATION OONB01BV0015

LAT. = 45D 33M 3S

LONG. = 65D 0M 48S

Description: Point Wolf River, mouth (WSC Gauge), Fundy National Park, Albert County.

STATION OONB01BV0016

LAT. = 45D 36M 36S

LONG. = 64D 57M 27S

Description: Upper Salmon (Alma) River at confluence with Kinnie Brook (WSC Gauge), Albert County.

STATION OONB01BV0017

LAT. = 45D 40M 9S

LONG. = 64D 59M 39S

Description: Broad River at falls, 1.82 km above junction with Upper Salmon (Alma) River, Albert County.

STATION OONB01BV0018

LAT. = 45D 41M 15S LONG. = 64D 57M 9S

Description: Forty Five River at covered bridge, Fundy National Park, Albert County.

STATION 01BRO1AD0001

LAT. = 47D 20M 20S LONG. = 68D 38M 50S

Description: Lac Baker, station 1, southern end of lake, W-E bridge to Island Church, S-N, treeline - mid-lake, Madawaska County.

STATION 01BRO1AD0002

LAT. = 47D 20M 50S LONG. = 68D 39M 50S

Description: Lac Baker, station 2, central zone of lake, W-E bridge to Island Church, S-N, large barn - mid-lake, Madawaska County.

STATION 01BRO1AD0003

LAT. = 47D 21M 35S LONG. = 68D 41M 15S

Description: Lac Baker, station 3, northern zone, W-E mid-lake, S-N footbridge, Madawaska County.

STATION 01BRO1AD0004

LAT. = LONG. =

Description: Lac Baker, combination of stations 1, 2 and 3, Madawaska County.

STATION 01BRO1AD0005

LAT. = 47D 22M 18S LONG. = 68D 42M 12S

Description: Lac Baker, station 4, upper north end of lake, Madawaska County.

STATION 01BRO1AF0004

LAT. = 47D 46M 20S LONG. = 68D 22M 30S

Description: Third Lake, Madawaska County.

STATION 01BRO1AF0005

LAT. = 47D 46M 20S LONG. = 68D 22M 20S

Description: Third Lake, Madawaska County.

STATION 01BRO1AH0001

LAT. = 47D 25M 30S LONG. = 66D 55M 15S

Description: Nictau Lake, station 1, NW end of lake, Restigouche County.

STATION 01BRO1AH0002

LAT. = 47D 25M 40S LONG. = 66D 54M 55S

Description: Nictau Lake, station 2, 275 m to north of Station 1, Restigouche County.

STATION 01BRO1AH0003

LAT. = 47D 25M 25S LONG. = 66D 53M 40S

Description: Nictau Lake, station 3, centre of lake, Restigouche County.

STATION 01BRO1AH0004

LAT. = 47D 25M 15S LONG. = 66D 52M 55S

Description: Nictau Lake, station 4, NE section of lake, Restigouche County.

STATION 01BRO1AH0005

LAT. = 47D 25M 25S LONG. = 66D 52M 15S

Description: Nictau Lake, station 5, cove at NE section of lake, Addington Parish, Restigouche County.

STATION 01BRO1AH0006

LAT. = 47D 25M 15S LONG. = 66D 52M 5S

Description: Nictau Lake, station 6, at entrance to Little Nictau Lake, Restigouche County.

STATION 01BRO1AH0007

LAT. = 47D 17M 40S LONG. = 67D 15M 00S

Description: Sisson Branch reservoir, NE arm, Victoria County.

STATION 01BRO1AH0008

LAT. = 47D 3M 15S LONG. = 66D 55M 30S

Description: Long Lake, station 1, north end, 100 m from dam, Victoria County.

STATION 01BRO1AH0009

LAT. = 47D 2M 15S LONG. = 66D 54M 40S

Description: Long Lake, station 2, 2000 m from station 1, mid-lake near east point, Victoria County.

STATION 01BRO1AH0010

LAT. = 47D 1M 45S LONG. = 66D 53M 15S

Description: Long Lake, station 3, 2000 m from station 2, mid-lake, Victoria County.

STATION 01BRO1AH0011

LAT. = 47D 0M 50S LONG. = 66D 51M 55S

Description: Long Lake, station 4, just before narrows at south end of lake, Victoria County.

STATION 01BRO1AH0012

LAT. = 47D 8M 55S LONG. = 66D 52M 15S

Description: Serpentine Lake, station 1, 1000 m from dam, Northumberland County.

STATION 01BRO1AH0013

LAT. = 47D 8M 25S LONG. = 66D 52M 0S

Description: Serpentine Lake, station 2, south of island near east shore, 1000 m from station 1, Northumberland County.

STATION 01BRO1AH0014

LAT. = 47D 7M 45S LONG. = 66D 51M 55S

Description: Serpentine Lake, station 3, slightly west side, 500 m south of large island, Northumberland County.

STATION 01BRO1AH0015

LAT. = 47D 7M 25S LONG. = 66D 51M 25S

Description: Serpentine Lake, station 4, 500 m from infall at south end, Northumberland County.

STATION 01BRO1AH0016

LAT. = 47D 0M 50S LONG. = 66D 58M 40S

Description: Trousers Lake, station 1, just before entering main part of lake, 1500 m from dam, Victoria County.

STATION 01BRO1AH0017

LAT. = LONG. =

Description: Trousers Lake, station 2, 1000 m from station 1, North Islands, Victoria County.

STATION 01BR01AH0018

LAT. = LONG. =

Description: Trousers Lake, station 3, half way down left leg, Victoria County.

STATION 01BR01AH0019

LAT. = 46D 59M 30S LONG. = 66D 56M 30S

Description: Trousers Lake, station 4, half way down right leg, Victoria County.

STATION 01BR01AK0001

LAT. = 45D 49M 28S LONG. = 67D 2M 24S

Description: Lake George, station 1, off NE shore by road, York County.

STATION 01BR01AK0002

LAT. = 45D 48M 25S LONG. = 67D 2M 24S

Description: Lake George, station 2, mouth of bay in SE corner, York County.

STATION 01BR01AK0003

LAT. = 45D 48M 25S LONG. = 67D 2M 53S

Description: Lake George, station 3, centre of lake, York County.

STATION 01BR01AK0004

LAT. = 45D 56M 20S LONG. = 67D 8M 40S

Description: Davidson Lake, station 1, located 250 m NW of shore road, approximately 100 m offshore, York County.

STATION 01BR01AK0005

LAT. = 45D 56M 12S LONG. = 67D 9M 5S

Description: Davidson Lake, station 2, approx. 450 m SW of station 1, York County.

STATION 01BR01AK0006

LAT. = 45D 56M 11S LONG. = 67D 9M 43S

Description: Davidson Lake, station 3, approx. 450 m SW of station 2, York County.

STATION 01BR01AK0007

LAT. = 45D 57M 27S LONG. = 66D 59M 24S

Description: Scotch Lake, station 1, located approx. 100 m out from centre of western shore, York County.

STATION 01BR01AK0008

LAT. = 45D 57M 27S LONG. = 66D 59M 0S

Description: Scotch Lake, station 2, middle of lake, located in centre of lake between stations 1 and 3, York County.

STATION 01BR01AK0009

LAT. = 45D 52M 55S LONG. = 67D 1M 15S

Description: Waterloo Lake, station 2.

STATION 01BR01AK0010

LAT. = 45D 52M 41S LONG. = 66D 54M 32S

Description: Kelly Creek Basin (Lake), approx. 200 m upstream from TCH, York County.

STATION 01BR01AK0011

LAT. = 45D 57M 25S LONG. = 66D 59M 25S

Description: Scotch Lake, station 3, west end of lake equal distance from three shores, York County.

STATION 01BRO1AM0001

LAT. = 45D 24M 12S LONG. = 66D 36M 54S

Description: South Oromocto Lake, station 1, located approx. 100 m from peninsula at eastern end of lake, Charlotte County.

STATION 01BRO1AM0002

LAT. = 45D 24M 18S LONG. = 66D 38M 9S

Description: South Oromocto Lake, station 2, located 500 m and 10 degrees NW of station 1, Charlotte County.

STATION 01BRO1AM0003

LAT. = 45D 25M 3S LONG. = 66D 38M 48S

Description: South Oromocto Lake, station 3, located at centre of lake, Charlotte County.

STATION 01BRO1AM0004

LAT. = 45D 25M 48S LONG. = 66D 39M 30S

Description: South Oromocto Lake, station 4, located approx. 200 m south of outlet to South Oromocto River, Charlotte County.

STATION 01BRO1AM0005

LAT. = 45D 47M 0S LONG. = 66D 31M 40S

Description: French Lake, station 1, east of provincial park, Sunbury County.

STATION 01BRO1AM0006

LAT. = 45D 46M 55S LONG. = 66D 32M 15S

Description: French Lake, station 2, in front of farm across from provincial park, Sunbury County.

STATION 01BRO1AM0007

LAT. = 45D 47M 15S LONG. = 66D 32M 20S

Description: French Lake, station 3, west of provincial park, Sunbury County.

STATION 01BRO1AM0008

LAT. = 45D 35M 10S LONG. = 67D 30M 5S

Description: Harvey Lake, station 1, located in town of Harvey, York County.

STATION 01BRO1AM0009

LAT. = 45D 35M 10S LONG. = 67D 30M 30S

Description: Harvey Lake, station 2, middle of lake in cove on west side of island, York County.

STATION 01BRO1AM0010

LAT. = 45D 35M 15S LONG. = 67D 30M 5S

Description: Harvey Lake, station 3, NW section of lake, located in town of Harvey, York County.

STATION 01BRO1AM0011

LAT. = 45D 35M 15S LONG. = 67D 29M 45S

Description: Harvey Lake, station 4, NE section of lake, near Hwy 636, York County.

STATION 01BRO1AM0012

LAT. = 45D 46M 35S LONG. = 66D 51M 40S

Description: Yoho Lake (Lake Erina), station 1, mouth of Yoho Stream, west of Fredericton, York County.

STATION 01BR01AM0013

LAT. = 45D 46M 25S LONG. = 66D 52M 15S

Description: Yoho Lake (Lake Erina), station 2, south end of lake, west of Fredericton, York County.

STATION 01NB01AM0014

LAT. = 45D 46M 55S LONG. = 66D 51M 40S

Description: Yoho Lake (Lake Erina), station 3, middle of lake, west of Fredericton, York County.

STATION 01BR01AM0015

LAT. = 45D 47M 20S LONG. = 66D 51M 10S

Description: Yoho Lake (Lake Erina), station 4, north end of lake in cove, York County.

STATION 01BR01AM0021

LAT. = 45D 38M 0S LONG. = 67D 0M 20S

Description: Oromocto Lake, station 1, west central off Caribou Point, York County.

STATION 01BR01AM0022

LAT. = 45D 36M 40S LONG. = 67D 0M 55S

Description: Oromocto Lake, station 2, 90 m offshore west side near lodge, York County.

STATION 01BR01AM0023

LAT. = 45D 35M 5S LONG. = 67D 1M 55S

Description: Oromocto Lake, station 3, 450 m off Bedford Point, west shore, York County.

STATION 01BR01AM0024

LAT. = LONG. =

Description: Oromocto Lake, station 4, south end of lake equal distance from three shores, York County.

STATION 01BR01AM0025

LAT. = 45D 36M 20S LONG. = 66D 57M 55S

Description: Oromocto Lake, station 5, central just before entrance to basin on east side at drainage, York County.

STATION 01BR01A00001

LAT. = 46D 1M 15S LONG. = 65D 54M 40S

Description: Grand Lake Survey, Cumberland Bay station 1, 5.5 km east of Cox Point east mid-channel.

STATION 01BR01A00002

LAT. = 42D 42M 18S LONG. = 35D 53M 9S

Description: Grand Lake Survey, Cumberland Bay station 2, mid-channel, 3 km east of Cox Point East.

STATION 01BR01A00003

LAT. = 42D 47M 57S LONG. = 36D 16M 48S

Description: Grand Lake Survey, Cumberland Bay station 3, mid-channel off Cox Point East.

STATION 01BR01A00004

LAT. = 45D 51M 30S LONG. = 66D 9M 0S

Description: Grand Lake Survey, lake transect L-1, bearing 293, to Indian Point from Purdy Shoals, mid-distance.

STATION 01BR01A00005

LAT. = 41D 7M 27S LONG. = 51D 35M 56S

Description: Grand Lake Survey, lake transect L-2, bearing 330, from light at Robertson's Point, station 6, mid-distance.

STATION 01BR01A00006

LAT. = 41D 52M 37S LONG. = 53D 45M 23S

Description: Grand Lake Survey, lake transect L-3, bearing 144, from light at Grand Point Bar to church, station 6, mid-distance.

STATION 01BR01A00007

LAT. = 42D 0M 43S LONG. = 54D 7M 15S

Description: Grand Lake Survey, lake transect L-4, bearing 276, from Fanjoys Point to Grand Point, station 6, mid-distance.

STATION 01BR01A00008

LAT. = 45D 56M 0S LONG. = 66D 2M 5S

Description: Grand Lake Survey, lake transect L-5, bearing 276, from Wiggin's Point to Palmer Point, station 6, mid-distance.

STATION 01BR01A00009

LAT. = 42D 20M 5S LONG. = 54D 59M 5S

Description: Grand Lake Survey, lake transect L-6, bearing 243, from Cumberland Point to Pops Point, station 6, mid-distance.

STATION 01BR01A00010

LAT. = 42D 49M 6S LONG. = 56D 18M 0S

Description: Grand Lake Survey, lake transect L-7, bearing 274, from Cox Point light, station 6, mid-distance.

STATION 01BR01A00011

LAT. = 46D 4M 50S LONG. = 65D 55M 25S

Description: Grand Lake Survey, lake transect L-5, bearing 48, from Indian Point, station 3, mid-distance.

STATION 01BR01A00012

LAT. = 45D 54M 36S LONG. = 66D 04M 36S

Description: Grand Lake Survey, lake transect 3, station 9, 150 m off Grand Point.

STATION 01BR01A00021

LAT. = 45D 43M 15S LONG. = 66D 3M 15S

Description: Washademoak Lake, station 1, adjacent to McDonald Point, Queens County.

STATION 01BR01A00022

LAT. = 45D 43M 50S LONG. = 66D 1M 30S

Description: Washademoak Lake, station 2, adjacent to Belyea Cove, Queens County.

STATION 01BR01A00023

LAT. = 45D 46M 20S LONG. = 65D 58M 50S

Description: Washademoak Lake, station 3, between Barnes Point and Appleby Point, Queens County.

STATION 01BR01A00024

LAT. = 45D 48M 40S LONG. = 65D 30M 55S

Description: Washademoak Lake, station 4, below Cambridge Narrows bridge, Queens County.

STATION 01BR01A00025

LAT. = 45D 51M 10S LONG. = 65D 28M 0S

Description: Washademoak Lake, station 5, adjacent to Picketts Cove, Queens County.

STATION 01BR01AP0001

LAT. = 45D 32M 54S LONG. = 65D 59M 48S

Description: Belleisle Bay, station 1, centre of bay off Anderson Point near Saint John River, Kings County.

STATION 01BR01AP0002

LAT. = 45D 35M 18S LONG. = 65D 56M 45S

Description: Belleisle Bay, station 2, centre of bay near outlet of Jenkins Cove and Browns Cove, Kings County.

STATION 01BR01AP0003

LAT. = 45D 37M 33S LONG. = 65D 53M 0S

Description: Belleisle Bay, station 3, centre of bay near outlet to Reddin Brook, Kings County.

STATION 01BR01AP0004

LAT. = 45D 38M 48S LONG. = 65D 51M 12S

Description: Belleisle Bay, station 4, centre of bay off Hatfield Point, Kings County.

STATION 01BR01AQ0001

LAT. = 45D 0M 39S LONG. = 66D 47M 18S

Description: Lake Utopia Survey, station 1, 800 m from base of Woodbury Cove at centre, Charlotte County.

STATION 01BR01AQ0002

LAT. = 45D 9M 18S LONG. = 66D 48M 39S

Description: Lake Utopia Survey, station 2, 750 m 25 degrees SW of station 3, Charlotte County.

STATION 01BR01AQ0003

LAT. = 45D 9M 42S LONG. = 66D 48M 18S

Description: Lake Utopia Survey, station 3, at outlet to Magaguadavic River, Charlotte County.

STATION 01BR01AQ0004

LAT. = 45D 9M 35S LONG. = 66D 47M 35S

Description: Lake Utopia Survey, station 4, centre of lake 10 degrees SW of station 3, Charlotte County.

STATION 01BR01AQ0005

LAT. = 45D 10M 53S LONG. = 66D 46M 38S

Description: Lake Utopia Survey, station 5, at outlet from Trout Lake, Charlotte County.

STATION 01BR01AQ0006

LAT. = 45D 11M 57S LONG. = 66D 47M 36S

Description: Lake Utopia Survey, station 6, upper end, Charlotte County.

STATION 01BR01AQ0007

LAT. = 45D 12M 5S LONG. = 66D 54M 20S

Description: Digdeguash Lake, station 1, mid-lake 800 m from SE end, Charlotte County.

STATION 01BRO1AQ0008
LAT. = 45D 12M 45S LONG. = 66D 54M 30S
Description: Digdeguash Lake, station 2, 350 m off mouth of Winter Stream, Charlotte County.

STATION 01BRO1AQ0009
LAT. = 45D 13M 15S LONG. = 66D 55M 10S
Description: Digdeguash Lake, station 3, half-way down lake, 25 m of major land outcropping on west shore, Charlotte County.

STATION 01BRO1AQ0010
LAT. = 45D 14M 35S LONG. = 66D 55M 55S
Description: Digdeguash Lake, station 4, mid-lake 400 m from north end of lake, Charlotte County.

STATION 01BRO1AQ0011
LAT. = 45D 44M 55S LONG. = 67D 12M 25S
Description: Magaguadavic Lake, station 1, centre of lake, 2500 m from upper end, York County.

STATION 01BRO1AQ0012
LAT. = 45D 44M 40S LONG. = 67D 11M 40S
Description: Magaguadavic Lake, station 2, 1000 m 25 degrees SW of station 1, York County.

STATION 01BRO1AQ0013
LAT. = 45D 44M 25S LONG. = 67D 11M 45S
Description: Magaguadavic Lake, station 3, 600 m due S of station 2 on opposite side of outcropping, York County.

STATION 01BRO1AQ0014
LAT. = 45D 41M 30S LONG. = 67D 12M 50S
Description: Magaguadavic Lake, station 4, 1500 m 60 degrees NW of Mink Brook outlet, York County.

STATION 01BRO1AQ0015
LAT. = 45D 41M 50S LONG. = 67D 10M 40S
Description: Magaguadavic Lake, station 5, 1000 m from outlet to Magaguadavic River, York County.

STATION 01BRO1AQ0016
LAT. = 45D 34M 55S LONG. = 67D 36M 35S
Description:

STATION 01BRO1AQ0017
LAT. = 45D 35M 05S LONG. = 67D 37M 20S
Description:

STATION 01BRO1AQ0018
LAT. = 45D 35M 55S LONG. = 67D 37M 55S
Description:

STATION 01BRO1AQ0019
LAT. = 45D 35M 55S LONG. = 67D 37M 05S
Description:

STATION 01BRO1AQ0020

LAT. = 45D 13M 35 LONG. = 66D 10M 45S

Description: Spruce Lake, station 1, 100 m from east end of lake at centre, Saint John County.

STATION 01BRO1AQ0021

LAT. = 45D 12M 42S LONG. = 66D 11M 27S

Description: Spruce Lake, station 3, at centre of lake where Judgate Lake enters Spruce Lake, Saint John County.

STATION 01BRO1AQ0022

LAT. = 45D 12M 9S LONG. = 66D 12M 15S

Description: Spruce Lake, station 3, at centre of lake where Judgate Lake enters Spruce Lake, Saint John County.

STATION 01BRO1AQ0526

LAT. = 45D 12M 13S LONG. = 66D 12M 35S

Description: Spruce Lake, station 5, west of station 3, other side of Middle Island, Saint John, Saint John County.

STATION 01BRO1AR0001

LAT. = 45D 49M 34S LONG. = 67D 32M 45S

Description: Skiff Lake, station 1, NW corner of lake 100 m offshore, York County.

STATION 01BRO1AR0002

LAT. = 45D 49M 37S LONG. = 67D 31M 52S

Description: Skiff Lake, station 2, near Mud Lake outlet, 100 m offshore 500 m 45 degrees SW, York County.

STATION 01BRO1AR0003

LAT. = 45D 49M 51S LONG. = 67D 31M 21S

Description: Skiff Lake, station 3, NE corner of lake 100 m offshore, York County.

STATION 01BRO1AR0004

LAT. = 45D 49M 19S LONG. = 67D 31M 20S

Description: Skiff Lake, station 4, centre of lake, York County.

STATION 01BRO1AR0006

LAT. = 45D 35M 53S LONG. = 67D 20M 36S

Description: Wauklahegan Lake, McAdam Lake, station 1, drainage at public boat landing and town drainage.

STATION 01BRO1AR0007

LAT. = 45D 36M 1S LONG. = 67D 20M 52S

Description: Wauklahagen Lake, McAdam Lake, station 2, SE end of lake, 250 m from Cotter Brook, York County.

STATION 01BRO1AR0008

LAT. = 45D 36M 20S LONG. = 67D 21M 36S

Description: Wauklahagen Lake, McAdam Lake, station 3, centre of lake, York County.

STATION 01BRO1AR0009

LAT. = 45D 33M 33S LONG. = 67D 22M 40S

Description: Wauklahegan Lake, McAdam Lake, station 4, near outlet to First and Spednik lakes and inlet from Third Lake at NW end, York County.

STATION 01BR01AR0010

LAT. = 45D 9M 10S

LONG. = 67D 5M 31S

Description: Chamcook Lake, station 1, mid-channel 90 m inside bay at NW end of lake.

STATION 01BR01AR0011

LAT. = 45D 8M 55S

LONG. = 67D 5M 31S

Description: Chamcook Lake Survey, station 5, 150 m directly north from centre of lake.

STATION 01BR01AR0012

LAT. = 45D 8M 25S

LONG. = 67D 4M 55S

Description: Chamcook Lake, station 7, bay SE of lake, 130 m from NE shore off island.

STATION 01BR01AR0013

LAT. = 45D 34M 20S

LONG. = 67D 50M 30S

Description: Madsley Lake, station 1, centre of lake.

STATION 01BR01AR0014

LAT. = 45D 49M 33S

LONG. = 67D 45M 36S

Description: North Lake, station 2, NE end of lake, 750 m from Monument Brook, York County.

STATION 01BR01AR0015

LAT. = 45D 49M 27S

LONG. = 67D 44M 36S

Description: North Lake, station 3, centre of lake, York County.

STATION 01BR01AR0016

LAT. = 45D 52M 18S

LONG. = 67D 40M 3S

Description: First Eel Lake, station 1, NE end of lake near Eel River outlet, York County.

STATION 01BR01AR0017

LAT. = 45D 51M 30S

LONG. = 67D 39M 15S

Description: First Eel Lake, station 2, centre of lake, York County.

STATION 01BR01AR0018

LAT. = 45D 50M 36S

LONG. = 67D 39M 39S

Description: First Eel Lake, station 3, south end of lake near outlet to Second Eel Lake, York County.

STATION 01BR01AR0019

LAT. = 45D 47M 33S

LONG. = 67D 37M 48S

Description: Second Eel Lake, station 2, south end of lake, 750 m from outlet of Third Eel Lake, York County.

STATION 01BR01AR0020

LAT. = 45D 48M 18S

LONG. = 67D 39M 3S

Description: Second Eel Lake, station 2, centre of lake, 1400 m north of station 1, York County.

STATION 01BR01AR0021

LAT. = 45D 48M 57S

LONG. = 67D 39M 21S

Description: Second Eel Lake, station 3, NW of lake near outlet to First Eel Lake, York County.

STATION 01BRO1AR0030

LAT. = 45D 11M 5S LONG. = 67D 6M 28S

Description: Limeburners Lake, station 3, north end of lake, 300 m from inlet, Charlotte County.

STATION 01BRO1AR0031

LAT. = 45D 10M 31S LONG. = 67D 6M 9S

Description: Limeburners Lake, station 2, south end of lake near outlet to Little Chamcook Lake, Charlotte County.

STATION 01BRO1AR0032

LAT. = 45D 10M 28S LONG. = 67D 5M 14S

Description: Gibson Lake, station 1, north end of lake, 100 m from inlet, Charlotte County.

STATION 01BRO1AR0033

LAT. = 45D 10M 17S LONG. = 67D 5M 10S

Description: Gibson Lake, station 2, middle of lake, 100 m from outlet to Little Chamcook Lake, Charlotte County.

STATION 01BRO1AR0034

LAT. = 45D 10M 14S LONG. = 67D 5M 1S

Description: Gibson Lake, station 3, south end of lake, 100 m from inlet to Welch Lake, Charlotte County.

STATION 01BRO1AR0035

LAT. = 45D 37M 51S LONG. = 67D 27M 39S

Description: Palfrey Lake, station 1, SE of lake at centre, 1300 m from base of cove, York County.

STATION 01BRO1AR0036

LAT. = 45D 41M 42S LONG. = 67D 43M 18S

Description: Spednik Lake, station 1, north end of lake at centre, 2000 m from base of Pirate Cove, York County.

STATION 01BRO1AR0037

LAT. = 45D 40M 57S LONG. = 67D 43M 18S

Description: Spednik Lake, station 2, north end of lake, 500 m from outlet of Azesko Lake, York County.

STATION 01BRO1AR0038

LAT. = 45D 37M 30S LONG. = 67D 39M 54S

Description: Spednik Lake, station 3, centre of lake, 2000 m NW of Birch Island, York County.

STATION 01BRO1AR0039

LAT. = 45D 35M 48S LONG. = 67D 34M 3S

Description: Spednik Lake, station 4, 300 m due south of Sandy Point, York County.

STATION 01BRO1AR0040

LAT. = 45D 36M 42S LONG. = 67D 33M 45S

Description: Spednik Lake, station 5, 700 m directly off Sandy Cove Point, towards Hardwood Island, York County.

STATION 01BR01AR0041

LAT. = 45D 35M 30S LONG. = 67D 31M 24S

Description: Spednik Lake, station 6, centre of lake, 1900 m SE of Hardwood Island, York County.

STATION 01BR01AR0042

LAT. = 45D 37M 42S LONG. = 67D 28M 51S

Description: Spednik Lake, station 7, centre of lake between Big Island and Pelfrey Lake outlet, York County.

STATION 01BR01AR0043

LAT. = 45D 37M 05 LONG. = 67D 26M 57S

Description: Spednik Lake, station 8, mouth of Diggity Cove at centre.

STATION 01BR01AR0044

LAT. = 45D 36M 21S LONG. = 67D 27M 51S

Description: Spednik Lake, station 9, 400 m off Haley Point (USA), York County.

STATION 01BR01AR0045

LAT. = 45D 34M 51S LONG. = 67D 25M 42S

Description: Spednik Lake, station 10, centre of lake, 250 m south of ice house, York County.

STATION 01BR01BJ0001

LAT. = 47D 58M 50S LONG. = 66D 40M 05

Description: Campbellton reservoir, station 1, centre of reservoir, 100 m from dam, Campbellton, Restigouche County.

STATION 01BR01AJ0002

LAT. = 47D 58M 50S LONG. = 66D 39M 35S

Description: Campbellton reservoir, station 2, centre of lake, 500 m from station 1, Campbellton, Restigouche County.

STATION 01BR01BJ0003

LAT. = 47D 58M 40S LONG. = 66D 38M 55S

Description: Smith Lake, station 1, centre of lake, 100 m from dam, Campbellton, Restigouche County.

STATION 01BR01BJ0004

LAT. = 47D 58M 40S LONG. = 66D 38M 25S

Description: Smith Lake, station 2, centre of lake, 600 m from station 1, Campbellton, Restigouche County.

STATION 01BR01BJ0005

LAT. = 47D 58M 55S LONG. = 66D 39M 45S

Description: Prichard Lake (Parker Lake), station 1, centre of lake, 1200 m from dam, Campbellton, Restigouche County.

STATION 01BR01BJ0006

LAT. = 47D 58M 55S LONG. = 66D 40M 20S

Description: Prichard Lake (Parker Lake), station 2, centre of lake, 1000 m from station 1, Campbellton, Restigouche County.

STATION 01BR01BJ0007

LAT. = 47D 47M 50S LONG. = 65D 58M 50S

Description: Antinouri Lake, station 1, north end, 100 m from inlet at centre, Restigouche County.

STATION 01BR01BJ0008

LAT. = 47D 47M 40S LONG. = 65D 58M 25S

Description: Antinouri Lake, station 2, centre of lake, 1000 m from station 1, Restigouche County.

STATION 01BR01BJ0009

LAT. = 47D 47M 5S LONG. = 65D 58M 15S

Description: Antinouri Lake, station 3, centre of lake at mouth of southernmost arm, Restigouche County.

STATION 01BR01BJ0010

LAT. = 47D 58M 55S LONG. = 66D 40M 55S

Description: Station 1, first small reservoir before water works, Sugarloaf Park, Campbellton, Restigouche County.

STATION 01BR01BK0001

LAT. = 47D 23M 15S LONG. = 66D 48M 40S

Description: Nepisiguit Lake, station 1, middle of bay, NW corner of lake, Northumberland County.

STATION 01BR01BK0002

LAT. = 47D 22M 55S LONG. = 66D 48M 0S

Description: Nepisiguit Lake, station 2, middle of west lake, Northumberland County.

STATION 01BR01BK0003

LAT. = 47D 22M 30S LONG. = 66D 48M 5S

Description: Nepisiguit Lake, station 3, SW corner of lake, Northumberland County.

STATION 01BR01BK0004

LAT. = 47D 22M 35S LONG. = 66D 46M 50S

Description: Camp Lake, station 4, centre lake, Northumberland County.

STATION 01BR01BM0001

LAT. = 46D 27M 45S LONG. = 66D 58M 12S

Description: Miramichi Lake, station 1, north end of lake near outlet to Miramichi River, York County.

STATION 01BR01BM0002

LAT. = 46D 27M 12S LONG. = 66D 57M 39S

Description: Miramichi Lake, station 2, SE end of lake near inlet, York County.

STATION 01BR01BM0003

LAT. = 46D 27M 42S LONG. = 66D 59M 3S

Description: Miramichi Lake, station 3, NW end of lake, York County.

STATION 01BR01BU0001

LAT. = 45D 58M 32S LONG. = 64D 34M 20S

Description: This station is an old mill pond on Le Blanc Creek at the rear of the Memramcook Institute, St. Joseph, Westmorland County.

STATION 01BRO1BV0018

LAT. = 45D 19M 3S LONG. = 65D 54M 24S

Description: Latimer Lake, station 1, east end of lake, 1000 m offshore, near underground pipeline, Saint John County.

STATION 01BRO1BV0019

LAT. = 45D 19M 9S LONG. = 65D 54M 36S

Description: Latimer Lake, station 2, north end of lake, 400 m offshore.

STATION 01BRO1BV0020

LAT. = 45D 18M 42S LONG. = 65D 54M 48S

Description: Latimer Lake, station 3, south end of lake, 250 m offshore, Saint John County.

STATION 01BRO1BV0021

LAT. = 45D 20M 18S LONG. = 65D 52M 21S

Description: Robertson Lake, station 1, at outlet of Loch Lomond, Saint John County.

STATION 01BRO1BV0022

LAT. = 45D 19M 45S LONG. = 65D 52M 57S

Description: Robertson Lake, station 2, at outlet to Latimer Lake (pipeline), Saint John County.

STATION 01BRO1BV0023

LAT. = 45D 20M 36S LONG. = 65D 52M 21S

Description: Loch Lomond, station 1, at outlet to Robertson Lake, Saint John County.

STATION 01BRO1BV0024

LAT. = 45D 22M 24S LONG. = 65D 51M 24S

Description: Loch Lomond, station 3, centre of lake, Saint John County.

STATION 01BRO1BV0026

LAT. = 45D 22M 30S LONG. = 65D 50M 20S

Description: Loch Lomond, station 4, near mouth of Ratcliffe Brook, NE end, Saint John County.

STATION 01NB01AF0005

LAT. = 47D 3M 3S LONG. = 67D 44M 30S

Description: Saint John River above Grand Falls dam, Madawaska County.

STATION 01NB01AG0001

LAT. = 46D 48M 33S LONG. = 67D 46M 9S

Description: Aroostook River at forebay bridge, Tinker Dam, Victoria County.

STATION 01NB01AG0002

LAT. = 46D 47M 42S LONG. = 67D 47M 21S

Description: Aroostook River at Canada-USA border (centre of river), Victoria County.

STATION 01NB01AG0003

LAT. = 46D 47M 54S LONG. = 66D 46M 45S

Description: Aroostook River, 800 m below Canada-USA border, Victoria County.

STATION 01NB01AH0001

LAT. = 47D 17M 30S LONG. = 67D 15M 0S

Description: Sisson Lake in middle of east branch of lake, Victoria County.

STATION 01NB01AH0005
LAT. = 46D 46M 51S LONG. = 67D 41M 39S
Description: Tobique River, 150 m above dam at narrows, Victoria County.

STATION 01NB01AH0006
LAT. = 46D 46M 48S LONG. = 67D 41M 42S
Description: Tobique River at Tobique Narrows dam, Victoria County.

STATION 01NB01AJ0002
LAT. = 46D 32M 27S LONG. = 67D 40M 6S
Description: Saint John River at dam, Beechwood, Carleton County.

STATION 01NB01AJ0003
LAT. = 46D 32M 30S LONG. = 67D 40M 6S
Description: Saint John River, 150 m above dam at Beechwood, Carleton County.

STATION 01NB01AJ0004
LAT. = 46D 32M 36S LONG. = 67D 40M 15S
Description: Saint John River, 400 m above dam at south bank of headpond, Beechwood, Victoria County.

STATION 01NB01AK0001
LAT. = 45D 56M 30S LONG. = 67D 9M 30S
Description: Davidson Lake in middle of lake, York County.

STATION 01NB01AK0009
LAT. = 45D 57M 39S LONG. = 67D 14M 54S
Description: Saint John River at new Nackawic bridge, Pokiok, York County.

STATION 01NB01AK0010
LAT. = 45D 57M 3S LONG. = 66D 52M 9S
Description: Saint John River at Mactaquac dam (bridge for forebay), York County.

STATION 01NB01AK0011
LAT. = 45D 57M 6S LONG. = 66D 52M 12S
Description: Saint John River, 150 m above control gates, Mactaquac headpond, York County.

STATION 01NB01AP0002
LAT. = 45D 47M 0S LONG. = 65D 59M 0S
Description: Washademoak Lake off McDonald Corner at mouth of Big Cove, Queens County.

STATION 01NB01AP0008
LAT. = 45D 13M 0S LONG. = 66D 11M 0S
Description: Spruce Lake outlet at pumphouse SW of Saint John, Saint John County.

STATION 01NB01AP0010
LAT. = 45D 49M 48S LONG. = 65D 57M 6S
Description: Washademoak Lake at Hwy 695 bridge, Cambridge-Narrows, Queens County.

STATION 01NB02AQ0002
LAT. = 45D 43M 0S LONG. = 67D 12M 0S
Description: Magaguadavic Lake in middle of lake, York County.

STATION 01NB01AQ0004
LAT. = 45D 14M 36S LONG. = 66D 18M 54S
Description: Loch Alva at outlet, Saint John County.

STATION 01NB01AQ0014
LAT. = 45D 11M 0S LONG. = 66D 47M 0S
Description: Lake Utopia in middle of lake, Charlotte County.

STATION 01NB01AQ0022
LAT. = 45D 12M 18S LONG. = 66D 19M 33S
Description: East (Branch) Reservoir at penstock intake, Saint John County.

STATION 01NB01AQ0023
LAT. = 45D 11M 15S LONG. = 66D 21M 21S
Description: West Branch Reservoir above dam, Saint John County.

STATION 01NB01AR0009
LAT. = 45D 13M 0S LONG. = 67D 1M 30S
Description: Kerr Lake in middle of lake, Charlotte County.

STATION 01NB01AR0010
LAT. = 45D 11M 51S LONG. = 67D 2M 0S
Description: Johnson Lake in middle of east part of lake, Charlotte County.

STATION 01NB01AR0015
LAT. = 45D 9M 50S LONG. = 67D 24M 35S
Description: Woodland Flowage near Woodland Junction (USA) from Maine Central Railway bridge, Charlotte County.

STATION 01NB01BE0001
LAT. = 47D 28M 35S LONG. = 66D 30M 0S
Description: Upsalquitch Lake in middle of lake, Northumberland County.

STATION 01NB01BE0009
LAT. = 47D 24M 15S LONG. = 65D 47M 36S
Description: Nepisiguit River at power dam headpond, Nepisiguit Falls, Gloucester County.

STATION 01NB02BV0002
LAT. = 45D 39M 27S LONG. = 65D 8M 24S
Description: Wolf Lake, 600 m north of outflow, Fundy National Park, Kings County.

STATION 01NB01BV0003
LAT. = 45D 37M 39S LONG. = 65D 4M 45S
Description: Bennett Lake, 300 m north of outflow, Fundy National Park, Albert County.

STATION 01NB01BV0017
LAT. = 45D 36M 39S LONG. = 65D 19M 21S
Description: Walton Lake in middle of lake, Kings County.

STATION 01NB01BV0017
LAT. = 45D 18M 57S LONG. = 65D 55M 21S
Description: Latimer Lake at pumphouse, Saint John County.

STATION 10BR01AF0003

LAT. = 47D 3M 5S LONG. = 67D 43M 25S

Description: Dr. Cyr summer cottage, Grand Falls, 8.0 km east of Grand Falls.

STATION 10BR01AF0004

LAT. = 47D 22M LONG. = 68D 20M

Description: Mr. A. Michaud, R.R. #2, Edmundston.

STATION 10BR01AF0005

LAT. = 47D 22M 10S LONG. = 68D 14M 50S

Description: Leonard Plourde, Rue Fournier, St. Basile, Madawaska County.

STATION 10BR01AF0010

LAT. = 47D 21M 35S LONG. = 68D 15M 20S

Description: Ronald Bois, Rue Principal, St. Basile, Madawaska County.

STATION 10BR01AF0015

LAT. = 50D 7M 45S LONG. = 68D 13M 35S

Description: Mr. Lavoie, Corridor St., St. Basile, well sample #10.

STATION 10BR01AF0017

LAT. = 47D 21M 30S LONG. = 68D 14M 20S

Description: G. Simard, St. Basile, well #11.

STATION 10BR01AF0018

LAT. = 47D 23M 20S LONG. = 68D 15M 30S

Description: Mr. Fernand Lavoie, St. Basile, Madawaska County, sample #14.

STATION 10BR01AF0022

LAT. = 47D 3M 40S LONG. = 67D 40M 30S

Description: Drummond Township, Grand Falls Area.

STATION 10BR01AF0025

LAT. = 47D 56M 25S LONG. = 68D 32M 20S

Description: Mr. Haskotte, St. Basile, kitchen tap.

STATION 10BR01AF0028

LAT. = 47D 00M LONG. = 67D 30M

Description: Mrs. C. Cote, well, Drummond Township, Victoria County.

STATION 10BR01AF0081

LAT. = 47D 2M 50S LONG. = 67D 44M 55S

Description: Town of Grand Falls, wells, Little River wells, Victoria County.

STATION 10BR01AF0097

LAT. = 47D 20M 45S LONG. = 68D 23M 5S

Description: Gilles Daigle, drilled well, Verret Office, Madawaska County.

STATION 10BR01AF0100

LAT. = 47D 15M 0S LONG. = 68D 41M 30S

Description: St. François Town Hall, well, St. François City Hall, Madawaska County.

STATION 10BR01AF0105

LAT. = 47D 21M 47S LONG. = 68D 20M 21S

Description: Edmundston Supply, well, Madawaska County.

STATION 10BR01AF0109
LAT. = 47D 32M 30S LONG. = 67D 22M 44S
Description: St. Leonard Supply, well, Madawaska County.

STATION 10BR01AF0110
LAT. = 47D 3M 6S LONG. = 66D 44M 33S
Description: Grand Falls Supply, well, Victoria County.

STATION 10BR01AF0113
LAT. = 47D 2M 55S LONG. = 67D 43M 50S
Description: Real Cassista, drilled well, Grand Falls, Victoria County.

STATION 10BR01AF0618
LAT. = 47D 2M 45S LONG. = 67D 44M 35S
Description: Grand Falls Wells (new), raw and finished water at pumps, Victoria County.

STATION 10BR01AH0006
LAT. = 46D 30M LONG. = 67D 00M
Description: Village of Plaster Rock, pumphouse, Plaster Rock, Victoria.

STATION 10BR01AJ0073
LAT. = 47D 41M 0S LONG. = 67D 28M 42S
Description: Hartland Supply, well.

STATION 10BR01AJ0074
LAT. = 46D 44M 20S LONG. = 67D 42M 24S
Description: Perth Supply, well.

STATION 10BR01AK0001
LAT. = 45D 51M 20S LONG. = 67D 58M 30S
Description: Well, York County.

STATION 10BR01AK0002
LAT. = 46D 00M LONG. = 67D 13M
Description: Town of Nackawic, municipal water supply, well no. 2, East of Nackawic River, north of Hwy 105.

STATION 10BR01AK0004
LAT. = 45D 57M 57S LONG. = 66D 45M 42S
Description: Fredericton, municipal water supply, Carriage Hill Rd., Silverwood.

STATION 10BR01AK0010
LAT. = 46D 8M 12S LONG. = 67D 14M 51S
Description: Gay Well, municipal water supply, Woodstock Rd., Fredericton.

STATION 10BR01AK0013
LAT. = 45D 54M 35S LONG. = 66D 35M 5S
Description: Andrina Hache, domestic water supply, 1467 Lincoln Rd., Fredericton.

STATION 10BR01AK0014
LAT. = 45D 56M 45S LONG. = 66D 37M 10S
Description: Test hole, 300 m SE of Fredericton Boat Club, Lincoln Rd., Fredericton.

STATION 10BR01AK0022

LAT. = 45D 58M 0S LONG. = 66D 51M 25S

Description: Mr. P. Currie, Keswick Ridge, cold tap.

STATION 10BR01AK0033

LAT. = 45D 58M 0S LONG. = 66D 51M 20S

Description: Elwin Billings, Keswick Ridge.

STATION 10BR01AK0034

LAT. = 45D 58M 5S LONG. = 66D 51M 10S

Description: Private water supply, Mrs. C. Hawkins, Keswick Ridge.

STATION 10BR01AK0037

LAT. = 45D 58M 55S LONG. = 66D 39M 30S

Description: Brian Barchard, well, cold water tap, Kingsley Rd, Nashwaaksis, Fredericton.

STATION 10BR01AK0038

LAT. = 45D 58M 5S LONG. = 66D 51M 25S

Description: Keswick Ridge, well no. 4, NW of the ODH Garage (near the trailer park).

STATION 10BR01AK0039

LAT. = 45D 45M LONG. = 66D 30M

Description: Clifford Jones, well, Kingsclear one mile dam, R.R. #6, Fredericton.

STATION 10BR01AK0042

LAT. = 45D 56M 45S LONG. = 66D 39M 30S

Description: City of Fredericton, well no. 7, Brookside Drive.

STATION 10BR01AK0052

LAT. = 45D 58M LONG. = 66D 41M

Description: City of Fredericton, Golf Club Road, Fredericton.

STATION 10BR01AK0061

LAT. = 45D 57M LONG. = 66D 38M

Description: City of Fredericton, 60 m below boat club, well no. 1, Lincoln Rd., Fredericton, York County.

STATION 10BR01AK0067

LAT. = 46D 7M 35S LONG. = 67D 11M 40S

Description: Jack Fleming, well, Millville.

STATION 10BR01AK0068

LAT. = 46D 7M 35S LONG. = 67D 11M 40S

Description: Mrs. Mary Sansom, well, Millville.

STATION 10BR01AK0072

LAT. = 45D 57M 51S LONG. = 66D 39M 33S

Description: Wilmot well no. 1, off Rookwood Ave., opposite Menzies, Fredericton.

STATION 10BR01AK0073

LAT. = 45D 57M 51S LONG. = 66D 39M 21S

Description: Wilmot well no. 3, in Wilmot Park just west of Tourist Bureau, Fredericton.

STATION 10BR01AK0074
LAT. = 45D 57M 51S LONG. = 66D 39M 24S
Description: Wilmot well no. 4, in Wilmot Park opposite RCMP driveway, Fredericton.

STATION 10BR01AK0075
LAT. = 45D 58M 05 LONG. = 66D 39M 30S
Description: Wilmot well no. 5, on bank of Saint John River west of Saint Anne's Point Barracks, Fredericton.

STATION 10BR01AK0093
LAT. = 46D 4M 35S LONG. = 67D 15M 24S
Description: Ralph Trail, cold water tap, kitchen sink, Temperance Vale, York County.

STATION 10BR01AK0096
LAT. = 45D 56M 15S LONG. = 66D 38M 55S
Description: Dept. of Transport, salt sand project, Fredericton.

STATION 10BR01AK0105
LAT. = 45D 58M 59S LONG. = 66D 36M 18S
Description: Marysville well no. 1, Marysville.

STATION 10BR01AK0106
LAT. = 45D 58M 41S LONG. = 66D 35M 51S
Description: Marysville well no. 2, Marysville, Fredericton.

STATION 10BR01AK0107
LAT. = 45D 58M 51S LONG. = 66D 39M 12S
Description: Nashwaaksis well no. 1, Nashwaaksis, Fredericton.

STATION 10BR01AK0108
LAT. = 45D 58M 48S LONG. = 66D 38M 57S
Description: Nashwaaksis well no. 2, Nashwaaksis, Fredericton.

STATION 10BR01AK0109
LAT. = 45D 58M 39S LONG. = 66D 38M 27S
Description: Nashwaaksis well no. 3, Nashwaaksis, Fredericton.

STATION 10BR01AK0111
LAT. = 45D 57M 29S LONG. = 66D 45M 58S
Description: Silverwood well no. 2, Silverwood, Fredericton.

STATION 10BR01AK0112
LAT. = 45D 57M 11S LONG. = 66D 35M 32S
Description: Barkers Point well no. 1, Barkers Point, Fredericton.

STATION 10BR01AK0113
LAT. = 45D 56M 56S LONG. = 66D 37M 24S
Description: Barkers Point well no. 2, Barkers Point, Fredericton.

STATION 10BR01AK0114
LAT. = 45D 57M 13S LONG. = 66D 40M 52S
Description: Hanwell Road well, Hanwell Road, Fredericton.

STATION 10BR01AK0115
LAT. = 45D 54M 25S LONG. = 66D 54M 50S
Description: Mactaquac Baptist Church, Kingsclear.

STATION 10BR01AK1008
LAT. = 45D 57M 35S LONG. = 66D 51M 45S
Description: Mactaquac Generating Station, Mactaquac.

STATION 10BR01AK0122
LAT. = 45D 57M 38S LONG. = 66D 37M 36S
Description: Bridge St. well, Fredericton.

STATION 10BR01AK0123
LAT. = 45D 58M 40S LONG. = 66D 39M 41S
Description: Maple St. well, Fredericton.

STATION 10BR01AK0124
LAT. = 45D 58M 24S LONG. = 66D 37M 52S
Description: St. Marys St. well, Fredericton.

STATION 10BR01AK0125
LAT. = LONG. =
Description: Highland Ave. well, Fredericton.

STATION 10BR01AK0127
LAT. = 45D 57M 14S LONG. = 66D 39M 19S
Description: Kirby Keyser, 549 Albert St., Fredericton.

STATION 10BR01AK0128
LAT. = 45D 57M 52S LONG. = 66D 46M 41S
Description: Well, 10 Birchcroft Dr., Silverwood, Fredericton.

STATION 10BR01AK0133
LAT. = 46D 37M 30S LONG. = 67D 57M 20S
Description: Ralph Jones well, Waterville, Carleton County.

STATION 10BR01AK0137
LAT. = 45D 51M LONG. = 67D 02M
Description: Mr. C. Pye, well water sample, Lake George, York County.

STATION 10BR01AK0146
LAT. = 45D 51M LONG. = 67D 02M
Description: Mr. W. King, well water drilled, Lake George, York County.

STATION 10BR01AK0151
LAT. = 45D 57M 11S LONG. = 66D 45M 58S
Description: City of Fredericton, well no. 2, Silverwood, Fredericton, York County.

STATION 10BR01AK0224
LAT. = 45D 44M LONG. = 67D 00M
Description: Wayne Breau, well water, Harvey Station, York County.

STATION 10BR01AK0227
LAT. = 45D 43M 45S LONG. = 67D 00M 15S
Description: Mr. R. Phillips, domestic water supply, Harvey Station, York County.

STATION 10BRO1AK0230
LAT. = 45D 49M 50S LONG. = 67D 4M 25S
Description: Warren Barnett, well water, Micmac Trailer Court, Lake George, York County.

STATION 10BRO1AK0241
LAT. = 45D 53M 10S LONG. = 66D 36M 55S
Description: Chippins Abatoir, well water, Industrial Park, Fredericton.

STATION 10BRO1AK0242
LAT. = 45D 59M 10S LONG. = 66D 49M 5S
Description: Bud Sullivan, well water, Keswick, York County.

STATION 10BRO1AK0358
LAT. = 45D 58M 56S LONG. = 66D 52M 11S
Description: Mr. R. Price, well water, Keswick Ridge.

STATION 10BRO1AK0364
LAT. = 45D 59M 18S LONG. = 66D 52M 37S
Description: W. Myers, well water, Keswick Ridge.

STATION 10BRO1AK0365
LAT. = 45D 59M 18S LONG. = 66D 51M 59S
Description: G. Grey, well water, Keswick Ridge.

STATION 10BRO1AK0387
LAT. = 45D 58M 47S LONG. = 66D 39M 34S
Description: Ronald TreCAPtin, domestic water supply, 129 Riverside Drive, Fredericton, York County.

STATION 10BRO1AK0388
LAT. = 45D 58M 0S LONG. = 66D 45M 15S
Description: Robert Gamble, private well, 16 Carriage Hill Dr., Box 19, Site 19 RR, Fredericton, York County.

STATION 10BRO1AK0389
LAT. = 45D 52M 47S LONG. = 66D 41M 17S
Description: Edgewood Estates, domestic water supply, New Maryland, York County.

STATION 10BRO1AK0397
LAT. = 46D 16M 0S LONG. = 67D 34M 56S
Description: Ralph Jones, domestic water supply, Waterville Car Co., R.R. 6, Woodstock.

STATION 10BRO1AK0400
LAT. = 45D 58M 53S LONG. = 66D 41M 49S
Description: Don Coles, domestic water supply, R.R. 4, Fredericton, York County.

STATION 10BRO1AK0412
LAT. = 45D 57M 57S LONG. = 66D 41M 43S
Description: Woodstock Road, municipal water supply, Fredericton.

STATION 10BRO1AK0418
LAT. = 46D 4M 4S LONG. = 66D 43M 14S
Description: P A 1, well, IHD Basin, Royal Road, York County.

STATION 10BR01AK0419

LAT. = 46D 4M 4S LONG. = 66D 43M 14S

Description: P A 2, well, IHC Basin, Royal Road, York County.

STATION 10BR01AK0422

LAT. = 45D 12M 47S LONG. = 66D 48M 12S

Description: P C 1, well IHD Basin, Royal Road, York County.

STATION 10BR01AK0423

LAT. = 45D 12M 47S LONG. = 66D 48M 12S

Description: P C 2, well, IHD Basin, Royal Road, York County.

STATION 10BR01AK0424

LAT. = 46D 5M 50S LONG. = 66D 43M 40S

Description: P B 1, well, IHD Basin, Royal Road, York County.

STATION 10BR01AK0425

LAT. = 46D 5M 50S LONG. = 66D 43M 40S

Description: P B 3, well, IHD Basin, Royal Road, York County.

STATION 10BR01AK0432

LAT. = LONG. =

Description: Dr. S.G. Grant, well no. 3, Applewood Estates.

STATION 10BR01AK0439

LAT. = 45D 20M 45S LONG. = 66D 40M 25S

Description: Penn Drill PGM, well 183, Red Rock-Nashwaak Brge, York County.

STATION 10BR01AK0440

LAT. = 46D 11M 8S LONG. = 66D 47M 50S

Description: Penn Drill PGM, hole 208, Tay Mills, York County.

STATION 10BR91AK0441

LAT. = 46D 5M 46S LONG. = 66D 49M 22S

Description: Penn Drill PGM, hole 228, Birdton, York County.

STATION 10BR01AK0442

LAT. = 46D 6M 16S LONG. = 66D 42M 22S

Description: Penn Drill PGM, hole 227, Herlett Settlement, York County.

STATION 10BR01AK0443

LAT. = 45D 59M 29S LONG. = 66D 40M 19S

Description: Penn Drill PGM, hole 249, Nashwaaksis, York County.

STATION 10BR01AK0444

LAT. = 46D 20M 20S LONG. = 66D 20M 28S

Description: Penn Drill PGM, well 206, York County.

STATION 10BR01AK0445

LAT. = 46D 7M 44S LONG. = 66D 28M 12S

Description: Penn Drill PGM, well 205, York County.

STATION 10BR01AK0446

LAT. = 46D 8M 20S LONG. = 66D 24M 40S

Description: Penn Drill PGM, well 204, York County.

STATION 10BRO1AK0447

LAT. = 45D 5M 25S LONG. = 66D 35M 55S

Description: Penn Drill PGM, well 226, York County.

STATION 10BRO1AK0453

LAT. = 45D 12M 47S LONG. = 66D 48M 12S

Description: PC 3, domestic water supply, Royal Road, York County.

STATION 10BRO1AK0458

LAT. = 45D 58M 44S LONG. = 66D 35M 19S

Description: Marysville 3, town well, Fredericton.

STATION 10BRO1AK0459

LAT. = 45D 59M 30S LONG. = 66D 39M 3S

Description: K-1 Killarney Road, town well, Fredericton, York County.

STATION 10BRO1AK0460

LAT. = 45D 59M 30S LONG. = 66D 39M 3S

Description: K-10 well Killarney, town well, Fredericton, York County.

STATION 10BRO1AK0466

LAT. = 45D 53M 15S LONG. = 66D 46M 39S

Description: Penn Drill PGM, well 270, Jct Hanwell Road and Mazerolle Rd.

STATION 10BRO1AK0467

LAT. = 45D 50M 37S LONG. = 66D 48M 51S

Description: Penn Drill PGM, well 287, Hanwell Road.

STATION 10BRO1AK0468

LAT. = 45D 45M 3S LONG. = 66D 55M 11S

Description: Penn Drill PGM, well 300, Hyrley Corner.

STATION 10BRO1AK0473

LAT. = 46D 3M 48S LONG. = 66D 42M 39S

Description: IHD Basin 62R, flowing well, Royal Road, Fredericton, York County.

STATION 10BRO1AK0477

LAT. = 46D 5M 50S LONG. = 66D 43M 40S

Description: IHD Basin, PB-2, Royal Road, York County.

STATION 10BRO1AK0486

LAT. = 45D 57M 42S LONG. = 66D 51M 36S

Description: NB Power Commission, well, Mactaquac, R.R. 6, York County.

STATION 10BRO1AK0488

LAT. = 46D 4M 27S LONG. = 66D 59M 33S

Description: Andrew Dillon, well, Zealand.

STATION 10BRO1AK0491

LAT. = 45D 58M 28S LONG. = 67D 14M 22S

Description: Town of Nackawic, well no. 1, Nackawic, Otis.

STATION 10BRO1AK0520

LAT. = 46D 3M 45S LONG. = 70D 56M 15S

Description: J. Macelwain, well, Temperance Vale, Carleton County.

STATION 10BRO1AK0523

LAT. = 45D 58M 30S LONG. = 66D 43M 15S

Description: Fred Taylor, well, Chateau Heights.

STATION 10BRO1AK0525

LAT. = 45D 58M 45S LONG. = 66D 43M 15S

Description: Mrs. Buchanan, well, Douglas.

STATION 10BRO1AK0531

LAT. = 45D 58M 20S LONG. = 66D 38M 05

Description: Hane Elhawary, well, Sunrise Estates, New Maryland.

STATION 10BRO1AK0015

LAT. = 46D 20M 59S LONG. = 66D 32M 47S

Description: Penn Drill PGM, hole 165, McGivney, York County.

STATION 10BRO1AK0016

LAT. = 46D 16M 15S LONG. = 66D 35M 57S

Description: Penn Drill PGM, hole 182, Glencoe, York County.

STATION 10BRO1AK0017

LAT. = 46D 13M 29S LONG. = 66D 30M 47S

Description: Penn Drill PGM, hole 181, Zionville, York County.

STATION 10BRO1AL0018

LAT. = 46D 11M 59S LONG. = 66D 39M 24S

Description: Penn Drill PGM, hole 207, Tay Valley, York County.

STATION 10BRO1AL0019

LAT. = 46D 16M 38S LONG. = 66D 35M 44S

Description: Penn Drill PGM, test hole no. 1182, Glencoe, York County.

STATION 10BRO1AL0020

LAT. = 46D 0M 45S LONG. = 66D 34M 50S

Description: Penn Drill PGM, well 248, Penniac.

STATION 10BRO1AL0021

LAT. = 46D 3M 19S LONG. = 66D 30M 34S

Description: Penn Drill PGM, well 225, well, Penniac.

STATION 10BRO1AL0027

LAT. = 46D 18M 30S LONG. = 71D 36M 05

Description: Penn Drill PGM, well B35.

STATION 10BRO1AL0028

LAT. = 46D 10M LONG. = 72D 50M

Description: Penn Drill PGM, well B37.

STATION 10BRO1AL0029

LAT. = 46D 20M LONG. = 65D 30M

Description: Penn Drill PGM, well B28.

STATION 10BRO1AL0031

LAT. = 46D 21M 43S LONG. = 67D 21M 30S

Description: Penn Drill PGM, well B38, Burpee.

STATION 10BR01AM0003

LAT. = 45D 54M 30S LONG. = 66D 35M 05

Description: John Porter, cold water tap, Nevers Road, Lincoln.

STATION 10BR01AM0004

LAT. = 45D 18M 35S LONG. = 66D 12M 25S

Description: Hamm Estate, 200 drilled well, Grand Bay, Kings County.

STATION 10BR01AM0014

LAT. = 45D 54M 55S LONG. = 66D 40M 30S

Description: Keith Rodgers (Atkinson Subdivision), domestic water supply, New Maryland.

STATION 10BR01AM0016

LAT. = 45D 47M 20S LONG. = 66D 28M 20S

Description: S.L. Patterson, private water supply, Oromocto.

STATION 10BR01AM0030

LAT. = 45D 46M 29S LONG. = 66D 28M 42S

Description: Stanley Howes residence, sample taken from cold water tap, Geary.

STATION 10BR01AM0034

LAT. = 45D 51M 25S LONG. = 66D 41M 05

Description: Mr. C. Giles, domestic water supply, P.O. Box 511, Station 15, in Nasonworth, Fredericton.

STATION 10BR01AM0052

LAT. = 45D 43M 25S LONG. = 67D 0M 40S

Description: Dr. George Fletcher, well, Harvey Station.

STATION 10BR01AM0054

LAT. = 45D 48M LONG. = 66D 37M

Description: Charles Holder, R.R. 5, Waasis Rd., Rusagonis.

STATION 10BR01AM0064

LAT. = 45D 44M LONG. = 67D 00M

Description: Harvey community well, 430 deep well, Harvey Station, York County.

STATION 10BR01AM0065

LAT. = 45D 46M LONG. = 66D 32M

Description: Mrs. Pat Forest, well water, French Lake, Sunbury County.

STATION 10BR01AM0067

LAT. = 45D 56M LONG. = 66D 38M

Description: Mr. Harold Pyne, well, Waasis Road, R.R. #5, Fredericton, Sunbury County.

STATION 10BR01AM0069

LAT. = 45D 58M LONG. = 66D 40M

Description: Mr. P. Pormigioni, well, Hanwell Rd., R.R. #6, Fredericton, York County.

STATION 10BR01AM0082

LAT. = 45D 56M 55S LONG. = 67D 45M 55S

Description: Adrien Therrien, well water, kitchen and basement taps, Smith Rd., R.R. #3, Oromocto, Sunbury County.

STATION 10BR01AM0091
LAT. = 45D 39M 55S LONG. = 66D 39M 55S
Description: Mr. Richard Gardner, well - drilled, Fredericton Junction, Sunbury County.

STATION 10BR01AM0092
LAT. = 45D 53M 30S LONG. = 66D 33M 10S
Description: Shannahan Subdivision, pump test, Lincoln, York County.

STATION 10BR01AM0152
LAT. = 45D 54M 3S LONG. = 66D 41M 40S
Description: Pine Ridge Estates, domestic water supply, after 24 hours pumping, New Maryland, York County.

STATION 10BR01AM0160
LAT. = 45D 51M 53S LONG. = 66D 42M 38S
Description: Imperial Oil drill hole 1, observation well, Charters Settlement.

STATION 10BR01AM0161
LAT. = 45D 49M 49S LONG. = 66D 39M 38S
Description: Imperial Oil drill hole 2, observation well, Nasonworth.

STATION 10BR01AM0162
LAT. = 45D 54M 36S LONG. = 66D 42M 29S
Description: Applewood Estates, domestic water supply, New Maryland, York County.

STATION 10BR01AM0163
LAT. = 45D 54M 36S LONG. = 66D 42M 29S
Description: Applewood Estates, domestic water supply, New Maryland, York County.

STATION 10BR01AM0165
LAT. = 45D 52M 35S LONG. = 66D 51M 25S
Description: Mountain View Estates Subdivision, municipal water supply, New Maryland.

STATION 10BR01AM0170
LAT. = 45D 50M 24S LONG. = 66D 34M 27S
Description: Paul Richard, well, R.R. #5, Waasis Road, Sunbury County.

STATION 10BR01AM0189
LAT. = 45D 39M 50S LONG. = 66D 40M 49S
Description: Tracy observation well 1304, Tracy, Sunbury County.

STATION 10BR01AM0191
LAT. = 45D 54M 44S LONG. = 66D 40M 26S
Description: Penn Drill PGM, test hole no. 1269, UNB Game Refuge, Hwy 101, Fredericton, York County.

STATION 10BR01AM0210
LAT. = 45D 48M 50S LONG. = 66D 40M 45S
Description: Burgess, well, Howorth Acres, Beaver Dam.

STATION 10BR01AM0212
LAT. = 45D 32M 34S LONG. = 67D 4M 57S
Description: Penn Drill PGM, well 309, Oromocto Lake Area, Oromocto Lake.

STATION 10BRO1AM0213
LAT. = 45D 40M 59S LONG. = 66D 53M 30S
Description: Penn Drill PGM, well 306, Cork Station.

STATION 10BRO1AM0214
LAT. = 45D 44M 27S LONG. = 66D 40M 12S
Description: Penn Drill PGM, well 298, Traceyville.

STATION 10BRO1AM0215
LAT. = 45D 44M 51S LONG. = 66D 57M 21S
Description: Lois Gonman, drilled well, Harvey, York County.

STATION 10BRO1AM0217
LAT. = 45D 44M 20S LONG. = 66D 50M 38S
Description: Penn Drill PGM, well 299, Yoho Stream.

STATION 10BRO1AM0218
LAT. = 45D 49M 59S LONG. = 66D 40M 23S
Description: Penn Drill PGM, well 286, Nasonworth.

STATION 10BRO1AM0219
LAT. = 45D 49M 35S LONG. = 66D 35M 42S
Description: Penn Drill PGM, well 285, Waas.

STATION 10BRO1AM0220
LAT. = 45D 45M 2S LONG. = 66D 34M 24S
Description: Penn Drill PGM, well 297, French Lake Area.

STATION 10BRO1AM0222
LAT. = 45D 35M 23S LONG. = 66D 47M 51S
Description: Penn Drill PGM, well 305, Little Lake Rd.

STATION 10BRO1AM0223
LAT. = 45D 36M 23S LONG. = 66D 47M 43S
Description: Penn Drill PGM, well 307, Little Lake.

STATION 10BRO1AM0224
LAT. = 45D 34M 20S LONG. = 66D 53M 57S
Description: Penn Drill PGM, well 308, Little Lake area.

STATION 10BRO1AM0225
LAT. = 45D 39M 29S LONG. = 66D 33M 28S
Description: Penn Drill PGM, well 303, Fredericton Junction.

STATION 10BRO1AM0226
LAT. = 45D 45M 1S LONG. = 66D 28M 41S
Description: Penn Drill PGM, well 296, Geary.

STATION 10BRO1AM0227
LAT. = 45D 54M 50S LONG. = 66D 40M 55S
Description: Applewood Acres, well 1, New Maryland, York County.

STATION 10BRO1AM0228
LAT. = 45D 54M 50S LONG. = 66D 40M 55S
Description: Applewood Acres, well 3, New Maryland, York County.

STATION 10BR01AM0234
 LAT. = 45D 51M 24S LONG. = 66D 41M 2S
 Description: New Brunswick Electric Power Commission well, Mill Road, New Maryland.

STATION 10BR01AM0271
 LAT. = 45D 43M 45S LONG. = 67D 0M 15S
 Description: Harvey observation well, well 45, Harvey, York County.

STATION 10BR01AN0003
 LAT. = 46D 10M 30S LONG. = 65D 53M 0S
 Description: Mr. Wayne Hicks, from Shell garage, domestic water supply, Chipman.

STATION 10BR01AN0005
 LAT. = 46D 10M 50S LONG. = 65D 53M 10S
 Description: Mr. W. Hill, Dicarlo Apts., Chipman

STATION 10BR01AN0007
 LAT. = 46D 33M 0S LONG. = 65D 53M 55S
 Description: Chipman Medical Centre, well 2, well sample, depth 12 m, Chipman.

STATION 10BR01AN0009
 LAT. = 46D 11M 10S LONG. = 65D 51M 55S
 Description: Mr. Douglas Branscombe, well, chipman.

STATION 10BR01AN0015
 LAT. = 46D 10M LONG. = 65D 53M
 Description: Chipman Regional High School, kitchen tap, Chipman.

STATION 10BR01AN0027
 LAT. = 46D 10M LONG. = 65D 53M
 Description: Mr. Chase, Main Street, across from Esso, Chipman.

STATION 10BR01AN0038
 LAT. = 46D 9M 20S LONG. = 65D 53M 35S
 Description: Government garage, Chipman.

STATION 10BR01AN0041
 LAT. = 46D 12M LONG. = 65D 58M
 Description: Mr. Willis Crawford, well water sample, R.R. #1, Salmon Creek, Queens County.

STATION 10BR01AN0051
 LAT. = 46D 10M 55S LONG. = 65D 53M 25S
 Description: Chipman Elementary School, well water, Chipman, Queens County.

STATION 10BR01AN0080
 LAT. = 46D 21M 55S LONG. = 65D 30M 56S
 Description: Penn Drill PGM, well 1157, Salmon River Rd., Kent County.

STATION 10BR01AN0082
 LAT. = 46D 19M 27S LONG. = 65D 30M 48S
 Description: Penn Drill PGM, well B23, Salmon River Rd., West Branch Coy Brook, Queens County.

STATION 10BRO1AN0083
LAT. = 46D 16M 45S LONG. = 65D 33M 3S
Description: Penn Drill PGM, well B24, Salmon River Road, Lake Stream, Kent County.

STATION 10BRO1AN0084
LAT. = 46D 21M 27S LONG. = 65D 21M 15S
Description: Penn Drill PGM, well B22, Harcourt.

STATION 10BRO1AN0086
LAT. = 46D 17M 55S LONG. = 65D 13M 50S
Description: Penn Drill PGM, well B25, Harcourt.

STATION 10BRO1AN0087
LAT. = 46D 21M 30S LONG. = 65D 31M 30S
Description: Penn Drill PGM, hole 157 - observation, Natural Resources cache well,
Salmon River Rd.

STATION 10BRO1AN0088
LAT. = 46D 22M 0S LONG. = 65D 30M 35S
Description: Penn Drill PGM, observation well 1157, Salmon River Rd.

STATION 10BRO1A00001
LAT. = 46D 5M 0S LONG. = 66D 4M 45S
Description: Minto Senior Citizen Housing, near government garage, Minto.

STATION 10BRO1A00005
LAT. = 45D 55M 20S LONG. = 66D 15M 35S
Description: F. Chase, well, cold water tap, Lakeville Corner.

STATION 10BRO1A00008
LAT. = 45D 54M 15S LONG. = 66D 35M 5S
Description: Pump house, Maritime Estates Trailer Park, Lincoln.

STATION 10BRO1A00011
LAT. = 45D 56M 40S LONG. = 67D 33M 0S
Description: Orville Bridges, test well, York County.

STATION 10BRO1A00015
LAT. = 45D 55M 10S LONG. = 66D 15M 35S
Description: Private water supply, Lakeville Corner (Grand Lake), well 3.

STATION 10BRO1A00016
LAT. = 45D 52M 20S LONG. = 66D 25M 15S
Description: Private water supply, Sargent White, 7.0 km below Burton Bridge, Burton.

STATION 10BRO1A00025
LAT. = 45D 54M 15S LONG. = 66D 35M 0S
Description: Maritime Mobile Homes Estate, well no. 1 (at pumphouse), Lincoln.

STATION 10BRO1A00035
LAT. = 46D 5M 10S LONG. = 66D 4M 45S
Description: Mrs. Douglas Denton, Box 36, Site 4, Minto.

STATION 10BR01A00045

LAT. = 45D 50M LONG. = 66D 07M

Description: Baptist parsonage, Jemseg.

STATION 10BR01A00052

LAT. = 45D 52M LONG. = 66D 27M

Description: Vance Troyner, River Valley Subdivision, Burton.

STATION 10BR01A00061

LAT. = 46D 4M 35S LONG. = 66D 3M 5S

Description: Mr. H. Yeamens, well water, P.O. Box 283, Minto, Sunbury County.

STATION 10BR01A00081

LAT. = 45D 59M 6S LONG. = 66D 11M 19S

Description: Test hole no. M-9, Minto, Sunbury County.

STATION 10BR01A00095

LAT. = 46D 10M 55S LONG. = 65D 52M 10S

Description: Woodrow Brogan, drilled well, Chipman, Queens County.

STATION 10BR01A00099

LAT. = 46D 0M 20S LONG. = 66D 17M 30S

Description: Penn Drill PGM, well 1246, Acadia Experimental Station, Sunbury County.

STATION 10BR01A00105

LAT. = 45D 58M 50S LONG. = 66D 28M 20S

Description: Penn Drill PGM, well W247, Noonan Dump by Burpee Game Reserve, Noonan.

STATION 10BR01A00106

LAT. = 45D 54M 56S LONG. = 66D 33M 1S

Description: Penn Drill PGM, well 268, Upper Maugerville.

STATION 10BR01A00107

LAT. = 45D 51M 48S LONG. = 66D 26M 57S

Description: Penn Drill PGM, well 284, Burton.

STATION 10BR01A00108

LAT. = 45D 51M 19S LONG. = 66D 19M 3S

Description: Penn Drill PGM, well 283, Swan Creek, Lower Burton.

STATION 10BR01A00109

LAT. = 45D 49M 55S LONG. = 66D 11M 33S

Description: Penn Drill PGM, well 282, Upper Gagetown.

STATION 10BR01A00114

LAT. = 45D 50M 58S LONG. = 66D 3M 0S

Description: Penn Drill PGM, well 281, Whites Cove.

STATION 10BR01A00115

LAT. = 45D 54M 33S LONG. = 65D 54M 40S

Description: Penn Drill PGM, well 262, Union Sett.

STATION 10BR01A00116

LAT. = 45D 54M 9S LONG. = 65D 46M 49S

Description: Penn Drill PGM, well 261, Coles Island.

STATION 10BR01A00117

LAT. = 45D 54M 15S LONG. = 65D 42M 38S

Description: Penn Drill PGM, well 260, Morrison Brook.

STATION 10BR01A00148

LAT. = 46D 3M 0S LONG. = 65D 56M 10S

Description: Fish hatchery, drill well, Minto, Sunbury County.

STATION 10BR01A00153

LAT. = 46D 10M 30S LONG. = 65D 53M 0S

Description: Chipman Regional High School, well, Chipman.

STATION 10BR01A00191

LAT. = 45D 49M 11S LONG. = 66D 33M 35S

Description: Penn Drill PGM, observation well 1268, Regent St., Fredericton.

STATION 10BR01AP0018

LAT. = 45D 44M 30S LONG. = 65D 31M 35S

Description: Mr. M. Atton, barn, well, Roachville Rd., Sussex.

STATION 10BR01AP0020

LAT. = 45D 46M 25S LONG. = 65D 43M 10S

Description: Cement Cartage, well, 84 m, Havelock, Kings County.

STATION 10BR01AP0024

LAT. = 45D 30M 40S LONG. = 65D 49M 50S

Description: Mr. Bacon, well, Hampton.

STATION 10BR01AP0032

LAT. = 45D 16M 29S LONG. = 66D 3M 35S

Description: Irving well, industrial park, Saint John.

STATION 10BR01AP0033

LAT. = 45D 24M 50S LONG. = 66D 11M 30S

Description: Charles Dee, drilled well, Greenwich Hill, Kings County.

STATION 10BR01AP0035

LAT. = 45D 33M 10S LONG. = 67D 15M 5S

Description: Everett Bacon, well, Church Lane, Hampton.

STATION 10BR01AP0040

LAT. = 45D 25M 15S LONG. = 65D 56M 30S

Description: Mr. Torin, Quispamsis, Kings County.

STATION 10BR01AP0047

LAT. = 45D 17M 25S LONG. = 66D 11M 40S

Description: Mrs. R. Donkin, well 85, Martinon R.R. 8, Saint John.

STATION 10BR01AP0048

LAT. = 45D 16M LONG. = 66D 03M

Description: Mrs. Bires, 1059, Sea Wood Lane West, Saint John.

STATION 10BR01AP0063

LAT. = 45D 25M 15S LONG. = 65D 56M 51S

Description: Kennebecasis School, well, Kennebecasis, Kings County.

STATION 10BR01AP0067

LAT. = 45D 30M 50S LONG. = 65D 50M 15S

Description: George Robertson, well, Church Lane, Hampton, Kings County.

STATION 10BR01AP0071

LAT. = 45D 23M 51S LONG. = 66D 17M 15S

Description: Salmon Rock Subdivision, domestic water supply, Wellsford, Saint John.

STATION 10BR01AP0072

LAT. = 46D 9M 46S LONG. = 65D 18M 38S

Description: Hole no. 196, observation well, Canaan Game Refuge.

STATION 10BR01AP0078

LAT. = 45D 30M 55S LONG. = 65D 50M 9S

Description: N. Michelson, domestic water supply, R.R. #4, Hampton.

STATION 10BR01AP0090

LAT. = 45D 40M 37S LONG. = 65D 48M 59S

Description: Bellisle High, well, Springfield, Kings County.

STATION 10BR01AP0094

LAT. = 45D 25M 25S LONG. = 65D 57M 33S

Description: Quispamsis School, domestic water supply, Quispamsis, Kings County.

STATION 10BR01AP0106

LAT. = 45D 40M 44S LONG. = 65D 48M 43S

Description: George Scovil, hand-dug well, Springfield, Kings County.

STATION 10BR01AP0108

LAT. = 45D 45M 27S LONG. = 66D 9M 37S

Description: Penn Drill PGM, well 294, Lower Gagetown.

STATION 10BR01AP0109

LAT. = 45D 43M 9S LONG. = 66D 4M 16S

Description: Penn Drill PGM, well 293, Lower Cambridge.

STATION 10BR01AP0110

LAT. = 45D 15M 25S LONG. = 66D 6M 9S

Description: Moosehead Breweries, 180 m deep well, Saint John.

STATION 10BR01AP0113

LAT. = 45D 29M LONG. = 66D 26M

Description: D. Jones, Clarendon.

STATION 10BR01AP0114

LAT. = 45D 31M 32S LONG. = 65D 49M 48S

Description: Everett Bacon, drilled well, Hampton, Kings County.

STATION 10BR01AP0118

LAT. = 45D 18M 30S LONG. = 66D 11M 30S

Description: Arthur Stewart, well, Grand Bay.

STATION 10BR01AP0126

LAT. = 45D 55M LONG. = 65D 18M

Description: Ralph Mayfield Jr., well, R.R. #2, Anagance.

STATION 10BR01AP0130

LAT. = 46D 4M 20S LONG. = 65D 21M 45S

Description: Raymond Corey, hand-dug well, East Cannon, Kings County.

STATION 10BR01AP0131

LAT. = 46D 12M 43S LONG. = 65D 30M 9S

Description: Penn Drill PGM, well B27, Harcourt.

STATION 10BR01AP0132

LAT. = 45D 43M 7S LONG. = 65D 30M 35S

Description: Town of Sussex, well, Sussex.

STATION 10BR01AP0200

LAT. = 45D 29M 30S LONG. = 65D 58M 15S

Description: Gary Moran, drilled well, 3 Bonney Road, Hampton, Kings County.

STATION 10BR01AP0238

LAT. = 45D 31M 15S LONG. = 65D 49M 10S

Description: Lubin Douthwright, well, 51 Hall Road, Hampton, Kings County.

STATION 10BR01AP0239

LAT. = 45D 31M 15S LONG. = 65D 49M 15S

Description: Arthur Chambers, well, 53 Hall Road, Hampton, Kings County.

STATION 10BR01AP0246

LAT. = 45D 31M 15S LONG. = 65D 49M 15S

Description: Donald O'Dell, well, Hampton, 10 Villa Drive, Kings County.

STATION 10BR01AP0290

LAT. = 45D 31M 40S LONG. = 65D 49M 30S

Description: McMonagle, well, 15 Centennial Drive, Hampton, Kings County.

STATION 10BR01AP0300

LAT. = 45D 31M 0S LONG. = 65D 50M 45S

Description: Vincent Hill, drilled well, 45 Kennebecasis River Road, Hampton, Kings County.

STATION 10BR01AP0305

LAT. = 45D 31M 0S LONG. = 65D 50M 45S

Description: Lloyd McKinley, well, 42 Kennebecasis Drive, Hampton, Kings County.

STATION 10BR01AP0307

LAT. = 45D 31M 0S LONG. = 65D 50M 45S

Description: Wayne Alexander, drilled well, 3 Hawthorne Lane, Hampton, Kings County.

STATION 10BR01AP0309

LAT. = 45D 31M 15S LONG. = 65D 50M 40S

Description: Frank Lorringham, drilled well, 74 Kennebecasis Road, Hampton, Kings County.

STATION 10BR01AP0311

LAT. = 45D 31M 0S LONG. = 65D 50M 45S

Description: Roland Alaby, well, 5 Hawthorne Lane, Hampton, Kings County.

STATION 10BR01AP0313

LAT. = 45D 31M 15S LONG. = 65D 50M 40S

Description: Bill McIntosh, well, 71 Kennebecasis Drive, Hampton, Kings County.

STATION 10BR01AP0350

LAT. = 45D 32M 20S LONG. = 65D 50M 15S

Description: Harry Campbell, drilled well, 150 Kennebecasis River Rd., Hampton, Kings County.

STATION 10BR01AP0357

LAT. = 45D 31M 55S LONG. = 65D 50M 40S

Description: George Lawson, drilled well, 6 Greenwood Crescent, Hampton, Kings County.

STATION 10BR01AP0370

LAT. = 45D 31M 05S LONG. = 65D 50M 30S

Description: James Splane, drilled well, 67 Church Lane, Hampton, Kings County.

STATION 10BR01AP0374

LAT. = 45D 30M 55S LONG. = 65D 50M 20S

Description: Laurie Mott Jr., drilled well, 44 Church Lane, Hampton, Kings County.

STATION 10BR01AP0375

LAT. = 45D 31M 55S LONG. = 65D 50M 45S

Description: Robert McInnes, drilled well, 75 Church Lane, Hampton, Kings County.

STATION 10BR01AP0379

LAT. = 45D 31M 55S LONG. = 65D 50M 45S

Description: D. Ritson, well, 76 Church Lane, Hampton, Kings County.

STATION 10BR01AP0384

LAT. = 45D 31M 05S LONG. = 65D 50M 30S

Description: Paul Richard, well, 61 Church Lane, Hampton, Kings County.

STATION 10BR01AP0453

LAT. = 45D 31M 45S LONG. = 65D 50M 05S

Description: Don Keirstead, drilled well, 240 Main Street, Hampton, Kings County.

STATION 10BR01AP0458

LAT. = 45D 31M 55S LONG. = 75D 50M 05S

Description: Harry Beyea, drilled well, 244 Main Street, Hampton, Kings County.

STATION 10BR01AP0462

LAT. = 45D 31M 45S LONG. = 65D 50M 05S

Description: Vernon Hickey, well, 242 Main Street, Hampton, Kings County.

STATION 10BR01AP0630

LAT. = 45D 32M 15S LONG. = 65D 50M 10S

Description: Murray Goodman, well, 306 Main Street, Hampton, Kings County.

STATION 10BR01AP0631

LAT. = 45D 32M 15S LONG. = 65D 50M 10S

Description: Gerald McRae, well, 298 Main Street, Hampton, Kings County.

STATION 10BRO1AP0632

LAT. = 45D 32M 15S LONG. = 65D 50M 10S

Description: L. Melick, well, 300 Main Street, Hampton, Kings County.

STATION 10BRO1AP0633

LAT. = 45D 32M 15S LONG. = 65D 50M 10S

Description: Ronald Ryan, well, 304 Main Street, Hampton, Kings County.

STATION 10BRO1AP0661

LAT. = 45D 31M 10S LONG. = 65D 50M 10S

Description: Frank Thompson, drilled well, 5 Clearwater Drive, Hampton, Kings County.

STATION 10BRO1AP0663

LAT. = 45D 31M 10S LONG. = 65D 50M 10S

Description: Stephen McCormick, drilled well, 10 Vernon Avenue, Hampton, Kings County.

STATION 10BRO1AQ0009

LAT. = 45D 45M LONG. = 67D 08M

Description: Mr. W.J. Pooley, well, Lake Magaguadavic, Fredericton.

STATION 10BRO1AQ0010

LAT. = 45D 3M 20S LONG. = 66D 48M 20S

Description: Savoie, well no. 1, Blacks Harbour.

STATION 10BRO1AQ0011

LAT. = 45D 3M 20S LONG. = 66D 48M 20S

Description: Munn, well no. 2, Blacks Harbour.

STATION 10BRO1AR0002

LAT. = 44D 44M 15S LONG. = 66D 45M 30S

STATION Lorena Tatton, well, cold water tap, Castalia, Grand Manan, Charlotte County.

STATION 10BRO1AR0009

LAT. = 44D 43M 42S LONG. = 66D 45M 30S

Description: Raymond Scott Morse, Grand Harbour, Grand Manan, Charlotte County.

STATION 10BRO1AR0010

LAT. = 44D 39M 02S LONG. = 66D 50M 32S

Description: Francis Allen Griffon, Seal Cove, Grand Manan, Charlotte County.

STATION 10BRO1AR0017

LAT. = 4D 31M 25S LONG. = 66D 55M 50S

Description: Well, Town of St. Stephen supply source, aquifer water table, St. Stephen.

STATION 10BRO1BJ0001

LAT. = 48D 0M 15S LONG. = 66D 37M 35S

Description: Mr. R. Englehart, domestic well water supply, 316 Mountain Road, Moncton.

STATION 10BRO1BJ0009

LAT. = 47D 39M 40S LONG. = 65D 38M 45S

Description: Grovehill Park Subdivision, water supply well, Bathurst.

STATION 10BRO1BJ0010

LAT. = 48D 1M 55S LONG. = 66D 31M 40S

Description: G.H. Robinson, Dalhousie Junction, Restigouche County.

STATION 10BRO1BJ0017
 LAT. = 48D 2M 10S LONG. = 66D 22M 30S
 Description: Eel River Indian Reserve, water supply well, Restigouche County.

STATION 10BRO1BJ0018
 LAT. = 48D 02M 10S LONG. = 66D 22M 38S
 Description: Eel River Bar Indian Reserve well, near canteen.

STATION 10BRO1BJ0023
 LAT. = 47D 36M LONG. = 65D 39M
 Description: Grove Hill 1, Town of Bathurst, well, Bathurst, Gloucester County.

STATION 10BRO1BJ0054
 LAT. = 47D 41M 50S LONG. = 65D 52M 35S
 Description: Leo Hache, kitchen tap, Nicholas Denys.

STATION 10BRO1BJ0055
 LAT. = 47D 41M 45S LONG. = 65D 53M 50S
 Description: Wilfred Hache, kitchen tap, Nicholas Denys.

STATION 10BRO1BJ0056
 LAT. = 47D 41M 20S LONG. = 65D 56M 5S
 Description: Omer Hache, kitchen tap, Robertville.

STATION 10BRO1BJ0058
 LAT. = 47D 59M 30S LONG. = 66D 41M 45S
 Description: City of Campbellton, well water, Campbellton, Restigouche County.

STATION 10BRO1BJ0059
 LAT. = 48D 3M 35S LONG. = 66D 22M 50S
 Description: Town of Dalhousie, well, Dalhousie, Restigouche County.

STATION 10BRO1BJ0063
 LAT. = 47D 43M 55S LONG. = 65D 45M 15S
 Description: Roland Boudreau, drilled well, Nigadoo, Gloucester County.

STATION 10BRO1BJ0065
 LAT. = 47D 42M 20S LONG. = 65D 43M 10S
 Description: Wilbrad Pelletier, drilled well, Beresford, Gloucester County.

STATION 10BRO1BJ0066
 LAT. = 47D 42M 20S LONG. = 65D 43M 10S
 Description: Flavien Arseneau, drilled well, Beresford, Gloucester County.

STATION 10BRO1BJ0068
 LAT. = 47D 43M 48S LONG. = 65D 44M 42S
 Description: Lorien Roy, well, Nigadoo, Gloucester County.

STATION 10BRO1BJ0069
 LAT. = 47D 43M 48S LONG. = 65D 44M 42S
 Description: Omer Roy, well, Nigadoo, Gloucester County.

STATION 10BRO1BJ0070
 LAT. = 47D 43M 51S LONG. = 65D 44M 36S
 Description: Norbert Arseneau, well, Nigadoo, Gloucester County.

STATION 10BRO1BJ0089

LAT. = 48D 0M 0S LONG. = 66D 20M 0S

Description: Charlo Town Supply, municipal supply, Charlo, Restigouche County.

STATION 10BRO1BJ0097

LAT. = 48D 3M 50S LONG. = 66D 29M 35S

Description: Real Gendron, drilled well, CP 1802, Dalhousie, Restigouche County.

STATION 10BRO1BL0001

LAT. = 47D 44M 35S LONG. = 66D 42M 50S

Description: Theophile Mallet, well, Shippegan, Gloucester County.

STATION 10BRO1BL0009

LAT. = 47D 49M 15S LONG. = 64D 37M 15S

Description: Lameque, last hydrant north of the village, 2.0 km from the production well, Gloucester County.

STATION 10BRO1BL0012

LAT. = 47D 49M 15S LONG. = 64D 37M 10S

Description: Lameque, test hole no. 10, Gloucester County.

STATION 10BRO1BL0015

LAT. = 47D 40M 15S LONG. = 65D 6M 30S

Description: Paquetville School, washroom tap, Paquetville, Gloucester County.

STATION 10BRO1BL0017

LAT. = 47D 48M 20S LONG. = 64D 40M 15S

Description: Claude Gionet, Point Alexandre, Lameque, Gloucester County.

STATION 10BRO1BL0064

LAT. = 47D 27M 37S LONG. = 65D 29M 1S

Description: Test hole no. 32, groundwater, Allardville, Gloucester County.

STATION 10BRO1BL0068

LAT. = 47D 13M 11S LONG. = 65D 10M 22S

Description: Test hole no. 46, groundwater, Neguac, Northumberland County.

STATION 10BRO1BL0075

LAT. = 47D 42M 26S LONG. = 65D 9M 34S

Description: Gerald Young, domestic water supply, Burnsville, Gloucester County.

STATION 10BRO1BL0076

LAT. = 47D 42M 33S LONG. = 65D 9M 15S

Description: Burnsville Piggery, stock water supply, Burnsville, Gloucester County.

STATION 10BRO1BL0077

LAT. = 47D 42M 26S LONG. = 65D 9M 16S

Description: William Young, domestic water supply, Burnsville, Gloucester County.

STATION 10BRO1BL0090

LAT. = 47D 48M 54S LONG. = 65D 10M 48S

Description: George Blanchard, well, Grande Anse, Gloucester County.

STATION 10BRO1BL0091
LAT. = 47D 48M 54S LONG. = 65D 10M 51S
Description: Armand Hebert, well, Grande Anse, Gloucester County.

STATION 10BRO1BL0093
LAT. = 47D 48M 18S LONG. = 64D 38M 30S
Description: Village of Lameque, well MW-1, Lameque, Gloucester County.

STATION 10BRO1BL0103
LAT. = 47D 30M 46S LONG. = 64D 54M 50S
Description: Tracadie town supply, well, Tracadie, Gloucester County.

STATION 10BRO1AL0104
LAT. = 47D 44M 45S LONG. = 64D 42M 30S
Description: Town of Shippegan, well, Shippegan, Gloucester County.

STATION 10BRO1BL0106
LAT. = 47D 47M 31S LONG. = 64D 57M 26S
Description: Town of Caraquet, well, Caraquet, Gloucester County.

STATION 10BRO1BM0009
LAT. = 46D 27M 30S LONG. = 66D 28M 30S
Description: Wayne Munn, well, Parker Ridge Road, Northumberland County.

STATION 10BRO1BN0002
LAT. = 46D 39M LONG. = 65D 53M
Description: Mr. Brian Peterson, well, Upper Blackville, Northumberland County.

STATION 10BRO1BN0003
LAT. = 46D 39M LONG. = 65D 53M
Description: Mr. John Brophy, well, Upper Blackville, Northumberland County.

STATION 10BRO1BN0004
LAT. = 46D 39M LONG. = 65D 53M
Description: Mrs. Blanche Arbeau, well, Upper Blackville, Northumberland County.

STATION 10BRO1BN0005
LAT. = 46D 33M 15S LONG. = 66D 8M 15S
Description: Mr. Alvin Brophy, well, Upper Blackville, Northumberland County.

STATION 10BRO1BN0008
LAT. = 46D 32M LONG. = 65D 45M
Description: Penn Drill PGM, well 113, Meadow Brook, Northumberland County.

STATION 10BRO1BN0009
LAT. = 46D 34M LONG. = 65D 40M
Description: Penn Drill PGM, well 127, Ryan Brook, Kent County.

STATION 10BRO1BN0010
LAT. = 46D 30M 59S LONG. = 65D 55M 26S
Description: Penn Drill PGM, hole 129, Beaver Brook, Northumberland County.

STATION 10BRO1BN0011
LAT. = 46D 37M 05S LONG. = 65D 57M 13S
Description: Penn Drill PGM, hole 116, Weaver Siding, Northumberland County.

STATION 10BRO18N0012

LAT. = 46D 35M 18S LONG. = 60D 2M 20S

Description: Penn Drill PGM, hole 117, Gilks, Northumberland County.

STATION 10BRO18N0013

LAT. = 46D 36M 3S LONG. = 66D 10M 5S

Description: Penn Drill PGM, well 118, Devils Back Lake, Northumberland County.

STATION 10BRO18N0014

LAT. = 46D 32M 5S LONG. = 66D 16M 30S

Description: Penn Drill PGM, hole 132, Priceville, Northumberland County.

STATION 10BRO18N0015

LAT. = 46D 31M 10S LONG. = 66D 1M 50S

Description: Penn Drill PGM, hole 130, Doaktown, Northumberland County.

STATION 10BRO18N0017

LAT. = 46D 25M 37S LONG. = 66D 2M 44S

Description: Penn Drill PGM, hole 145, Bear Brook, Northumberland County.

STATION 10BRO18N0018

LAT. = 46D 27M 10S LONG. = 65D 59M 27S

Description: Penn Drill PGM, hole 144, McKenzie Brook, Northumberland County.

STATION 10BRO18N0019

LAT. = 46D 29M 32S LONG. = 66D 10M 11S

Description: Penn Drill PGM, hole 131, Doaktown, Northumberland County.

STATION 10BRO18N0020

LAT. = 46D 25M 34S LONG. = 66D 11M 39S

Description: Penn Drill PGM, hole 146, Muzroll Lake, Northumberland County.

STATION 10BRO18N0023

LAT. = 46D 19M 8S LONG. = 66D 25M 27S

Description: Penn Drill PGM, test hole 164, North Cains, York County.

STATION 10BRO18N0024

LAT. = 46D 25M 21S LONG. = 66D 19M 46S

Description: Penn Drill PGM, test hole 147, East Branch, Burnt Land Brook, York County.

STATION 10BRO18N0025

LAT. = 46D 25M 36S LONG. = 66D 26M 47S

Description: Penn Drill PGM, hole 148, Astle Station, York County.

STATION 10BRO18N0037

LAT. = 46D 29M 45S LONG. = 65D 41M 21S

Description: Penn Drill PGM, B20, well, Blackville, Northumberland County.

STATION 10BRO18N0038

LAT. = 46D 31M 51S LONG. = 69D 8M 30S

Description: Penn Drill PGM, B15, well, Gray Rapids, Northumberland County

STATION 10BRO18N0039

LAT. = 46D 20M 52S LONG. = 69D 7M 41S

Description: Penn Drill PGM, B21, well, Six Mile Brooke, Northumberland County.

STATION 10BR01BN0040

LAT. = 46D 26M 3S LONG. = 69D 8M 10S

Description: Penn Drill PGM, 817, well, Upper Blackville, Northumberland County.

STATION 10BR01BN0041

LAT. = 46D 8M 26S LONG. = 74D 33M 18S

Description: Penn Drill PGM, 834, well, Bantalar Game Refuge, Northumberland County.

STATION 10BR01BN0042

LAT. = 46D 33M 19S LONG. = 66D 7M 22S

Description: Town of Doaktown, well, Doaktown, Northumberland County.

STATION 10BR01B00001

LAT. = 47D 1M 10S LONG. = 65D 27M 40S

Description: Chatham Legion, bypass well, Henderson Street extension and bypass highway, Chatham, Northumberland County.

STATION 10BR01B00002

LAT. = 47D 1M 40S LONG. = 65D 27M 40S

Description: Chatham, McIntosh well (off McIntosh Street), Northumberland County.

STATION 10BR01B00003

LAT. = 47D 1M 30S LONG. = 65D 28M 30S

Description: Henderson Street, well, near Chatham High School, Chatham, Northumberland County.

STATION 10BR01B00025

LAT. = 47D 1M 10S LONG. = 65D 28M 10S

Description: Nicol Street, well, at end of street on the right, Chatham, Northumberland County.

STATION 10BR01B00026

LAT. = 47D 1M 25S LONG. = 65D 28M 30S

Description: Ellis Street, well, Chatham, Northumberland County.

STATION 10BR01B00027

LAT. = 47D 1M 45S LONG. = 65D 28M 0S

Description: Cassidy Street, well, Chatham, Northumberland County.

STATION 10BR01B00028

LAT. = 47D 1M 35S LONG. = 65D 27M 50S

Description: Howard Street, well, Chatham, Northumberland County.

STATION 10BR01B00029

LAT. = 47D 1M 15S LONG. = 65D 27M 10S

Description: Henderson Street extension, well, Chatham, Northumberland County.

STATION 10BR01B00030

LAT. = 47D 2M 0S LONG. = 65D 28M 0S

Description: Duke Street, well, Chatham, Northumberland County.

STATION 10BR01B00031

LAT. = 47D 1M 20S LONG. = 65D 27M 50S

Description: Richard Street, well, Chatham, Northumberland County.

STATION 10BR01B00036
LAT. = 47D 2M 0S LONG. = 65D 26M 55S
Description: Private water supply, 500 West, Vanderberg, well, Chatham, Northumberland County.

STATION 10BR01B00037
LAT. = 47D 2M 5S LONG. = 65D 26M 50S
Description: Private water supply, 100 East, Vanderberg, Chatham, Northumberland County.

STATION 10BR01B00042
LAT. = 47D 1M 50S LONG. = 65D 28M 0S
Description: Park Street, well, Chatham, Northumberland County.

STATION 10BR01B00086
LAT. = LONG. =
Description: Mrs. Emmanuel Savoie, kitchen tap, Neguac, Northumberland County.

STATION 10BR01B00096
LAT. = 47D 1M 52S LONG. = 65D 27M 53S
Description: Town of Chatham municipal water supply, Martin Pump No. 7, Chatham, Northumberland County.

STATION 10BR01B00119
LAT. = 46D 45M 41S LONG. = 65D 26M 53S
Description: Test hole no. 87, observation well, North Rogersville, Northumberland County.

STATION 10BR01B00120
LAT. = 46D 49M 56S LONG. = 65D 23M 58S
Description: Test hole no. 77, observation hole, East Collette, Northumberland County.

STATION 10BR01B00121
LAT. = 46D 42M 56S LONG. = 65D 31M 47S
Description: Test hole no. 78, observation well, Barnaby River, Northumberland County.

STATION 10BR01B00122
LAT. = 46D 53M 52S LONG. = 65D 37M 2S
Description: Test hole no. 79, observation well, Kirkwood, Northumberland County.

STATION 10BR01B00123
LAT. = 46D 49M 56S LONG. = 65D 23M 58S
Description: Test hole no. 70, observation well, East Collette, Northumberland County.

STATION 10BR01B00124
LAT. = 45D 51M 39S LONG. = 65D 28M 26S
Description: Test hole no. 88, observation well, West Collette, Northumberland County.

STATION 10BR01B00126
LAT. = 46D 41M 37S LONG. = 65D 31M 51S
Description: Test hole no. 100, observation well, Marcelville, Northumberland County.

STATION 10BR01B00127
LAT. = 46D 39M 16S LONG. = 65D 37M 32S
Description: Penn Drill PGM, well 101, Blackville, Northumberland County.

STATION 10BR01B00128
LAT. = 46D 36M 18S LONG. = 65D 37M 42S
Description: Penn Drill PGM, well 114, Blackville, Northumberland County.

STATION 10BR01B00129
LAT. = 46D 31M 3S LONG. = 65D 45M 12S
Description: Penn Drill PGM, well 128, Sabbies River, Northumberland County.

STATION 10BR01B00130
LAT. = 46D 36M 50S LONG. = 65D 42M 26S
Description: Penn Drill PGM, well 115, Cains River, Northumberland County.

STATION 10BR01B00131
LAT. = 46D 41M 10S LONG. = 65D 46M 45S
Description: Penn Drill PGM, well, Howard, Northumberland County.

STATION 10BR01B00132
LAT. = 46D 42M 16S LONG. = 65D 54M 24S
Description: Penn Drill PGM, well 103, Blackville North, Bartholomew, Northumberland County.

STATION 10BR01B00133
LAT. = 46D 41M 7S LONG. = 66D 3M 18S
Description: Penn Drill PGM, well 104, Bartholomew River, Northumberland County.

STATION 10BR01B00134
LAT. = 46D 45M 29S LONG. = 66D 2M 55S
Description: Penn Drill PGM, hole 92, Dungarvon River area, Northumberland County.

STATION 10BR01B00135
LAT. = 46D 42M 43S LONG. = 60D 12M 57S
Description: Penn Drill PGM, well 105, Jacks Brook, Northumberland County.

STATION 10BR01B00136
LAT. = 46D 46M 12S LONG. = 65D 46M 3S
Description: Penn Drill PGM, well 90, Barnettville, Northumberland County.

STATION 10BR01B00137
LAT. = 46D 50M 54S LONG. = 65D 48M 5S
Description: Penn Drill PGM, well 80, West Branch Indiantown Brook, Northumberland County.

STATION 10BR01B000138
LAT. = 46D 46M 19S LONG. = 65D 54M 2S
Description: Penn Drill PGM, well 91, Pine Island Brook, Northumberland County.

STATION 10BR01B00142
LAT. = 46D 36M 30S LONG. = 66D 17M 0S
Description: Penn Drill PGM, well 119, Northumberland County.

STATION 10BR01B00143
LAT. = 46D 39M 30S LONG. = 66D 19M 30S
Description: Penn Drill PGM, well 106, Northumberland County.

STATION 10BRO1B00144

LAT. = 46D 40M 5S LONG. = 65D 50M 55S

Description: Penn Drill PGM, well 1116, Blackville, Northumberland County.

STATION 10BRO1B00146

LAT. = 47D 0M 16S LONG. = 65D 28M 23S

Description: CFB Chatham, observation well, Chatham, Northumberland County.

STATION 10BRO1B00147

LAT. = 46D 31M 55S LONG. = 71D 51M 25S

Description: Dept. of Nat. Resources well, Muzroll Brook, Northumberland County.

STATION 10BRO1B0014C

LAT. = 47D 1M 11S LONG. = 65D 24M 24S

Description: Town of Chatham, test hole no. 6, Gordons Road, Chatham, Northumberland County.

STATION 10BRO1B00152

LAT. = 46D 32M 18S LONG. = 65D 23M 24S

Description: Penn Drill PGM, B18, well, Noinville, Northumberland County.

STATION 10BRO1B00153

LAT. = 46D 41M 39S LONG. = 65D 28M 24S

Description: Penn Drill PGM, B14, well, Rogersville, Northumberland County.

STATION 10BRO1B00156

LAT. = 46D 47M LONG. = 65D 45M

Description: Penn Drill PGM, B13, well, Grey Rapids, Northumberland County.

STATION 10BRO1B00002

LAT. = 46D 56M LONG. = 65D 55M

Description: Mrs. S. Foran, well, Lyttleton, Northumberland County.

STATION 10BRO1B00003

LAT. = 46D 41M 35S LONG. = 65D 5M 10S

Description: DOH yard well, St. Ignace, Kent County.

STATION 10BRO1B00011

LAT. = 47D 38M 10S LONG. = 65D 0M 30S

Description: Georgina Maillet, water supply well, 235 St. Louis Street, St. Louis de Kent, Kent County.

STATION 10BRO1B00012

LAT. = 46D 44M 1S LONG. = 64D 58M 30S

Description: Pierre Babineau, water supply well, 148 St. Louis Street, St. Louis de Kent, Kent County.

STATION 10BRO1B00019

LAT. = 46D 38M 31S LONG. = 64D 42M 24S

Description: Rexton High School, domestic water supply, Rexton, Kent County.

STATION 10BRO1B00025

LAT. = 46D 56M 57S LONG. = 65D 23M 58S

Description: Hole no. 69, observation well, Weldfield Settlement, Kent County.

STATION 10BRO1BR0026

LAT. = 47D 0M 26S LONG. = 65D 0M 32S

Description: Hole no. 66, observation well, Baie Ste-Anne, Kent County.

STATION 10BRO1BR0035

LAT. = 46D 40M 51S LONG. = 65D 10M 0S

Description: Test hole no. 97, observation well, Cameron Mills, Kent County.

STATION 10BRO1BR0036

LAT. = 46D 36M 16S LONG. = 61D 14M 42S

Description: Test hole no. 110, observation well, Kent Lake, Kent County.

STATION 10BRO1BR0041

LAT. = 46D 33M 5S LONG. = 64D 46M 20S

Description: Old people home, well, Ste-Anne-de-Kent, Kent County.

STATION 10BRO1BR0043

LAT. = 46D 35M 40S LONG. = 65D 24M 57S

Description: Penn Drill PGM, B16, well, Harcourt, Kent County.

STATION 10BRO1BR0044

LAT. = 46D 25M LONG. = 57D 40M

Description: Penn Drill PGM, B19, well, Salmon River Road, Kent County.

STATION 10BRO1BS0008

LAT. = 46D 41M 9S LONG. = 64D 59M 51S

Description: Hole no. 96, observation well, Saint-Charles Nord, Kent County.

STATION 10BRO1BS0010

LAT. = 46D 36M 13S LONG. = 64D 59M 28S

Description: Hole no. 109, observation well, Indian Reserve Number 15, Molus River, Kent County.

STATION 10BRO1BS0011

LAT. = 46D 36M 49S LONG. = 64D 54M 34S

Description: Hole no. 108, observation well, Rexton, Kent County.

STATION 10BRO1BS0012

LAT. = 46D 39M 45S LONG. = 64D 46M 53S

Description: Hole no. 121, observation well, North Bella Phillip, Kent County.

STATION 10BRO1BS0015

LAT. = 46D 24M 23S LONG. = 64D 55M 45S

Description: Hole no. 136, observation well, Saint Lazare, Kent County.

STATION 10BRO1BS0016

LAT. = 46D 25M 57S LONG. = 64D 46M 49S

Description: Hole no. 135, observation well, North of Roy, Kent County.

STATION 10BRO1BS0018

LAT. = 46D 25M 43S LONG. = 64D 39M 44S

Description: Hole no. 134, observation well, Ward Corner, Kent County.

STATION 10BRO1BS0021
 LAT. = 46D 19M 16S LONG. = 64D 33M 38S
 Description: Hole no. 149, observation well, Saint Marcel, Kent County.

STATION 10BRO1BS0022
 LAT. = 46D 15M 05 LONG. = 64D 34M 45S
 Description: Hole no. 166, observation well, Kent County.

STATION 10BRO1BS0025
 LAT. = 46D 21M 33S LONG. = 64D 44M 55S
 Description: St. Anthony domestic water supply, St. Anthony, Kent County.

STATION 10BRO1BS0034
 LAT. = 46D 4M 8S LONG. = 65D 34M 5S
 Description: Penn Drill PGM, well 221, Canaan Forks, Queens County.

STATION 10BRO1BS0035
 LAT. = 45D 58M 45S LONG. = 65D 40M 29S
 Description: Penn Drill PGM, well 240, Brookvale, Queens County.

STATION 10BRO1BS0041
 LAT. = 46D 19M 33S LONG. = 65D 0M 58S
 Description: Penn Drill PGM, well 153, St. Paul, Kent County.

STATION 10BRO1BS0042
 LAT. = 46D 20M 59S LONG. = 65D 11M 5S
 Description: Penn Drill PGM, well 154, Coal Branch, Kent County.

STATION 10BRO1BS0043
 LAT. = 46D 22M 17S LONG. = 65D 16M 40S
 Description: Penn Drill PGM, well 155, Saint Sosime, Kent County.

STATION 10BRO1BS0044
 LAT. = 46D 28M 9S LONG. = 65D 12M 4S
 Description: Penn Drill PGM, well 139, Bryants Corner, Kent County.

STATION 10BRO1BS0045
 LAT. = 46D 27M 31S LONG. = 65D 8M 27S
 Description: Penn Drill PGM, well 138, Emerson, Kent County.

STATION 10BRO1BS0049
 LAT. = 46D 23M 43S LONG. = 65D 44M 36S
 Description: Penn Drill PGM, well 143, Kent County.

STATION 10BRO1BS0050
 LAT. = 46D 21M 35S LONG. = 65D 40M 45S
 Description: Penn Drill PGM, well 158, Kent County.

STATION 10BRO1BS0051
 LAT. = 46D 21M 24S LONG. = 65D 32M 28S
 Description: Penn Drill PGM, well 157, Little Forks Cache, Kent County.

STATION 10BRO1BS0053
 LAT. = 46D 30M 51S LONG. = 65D 17M 6S
 Description: Penn Drill PGM, well 124, Mortimer, Kent County.

STATION 10BR01BS0054

LAT. = 46D 30M 44S LONG. = 65D 9M 40S

Description: Penn Drill PGM, well 123, Smiths Corner, Kent County.

STATION 10BR01BS0056

LAT. = 46D 15M 55S LONG. = 64D 34M 17S

Description: Penn Drill PGM, observation well, Shediak Bridge, Westmorland County.

STATION 10BR01BS0057

LAT. = 46D 38M 23S LONG. = 64D 52M 25S

Description: Penn Drill PGM, well 1094, Rexton, Kent County.

STATION 10BR01BS0059

LAT. = 46D 36M 15S LONG. = 64D 59M 28S

Description: Penn Drill PGM, well 1109, Upper Rexton, Kent County.

STATION 10BR01BS0060

LAT. = 46D 28M 9S LONG. = 65D 12M 4S

Description: Penn Drill PGM, well 1139, Bryants Corner, Kent County.

STATION 10BR01BT0001

LAT. = 46D 3M 25S LONG. = 64D 5M 20S

Description: Memorial School well, Port Elgin, Westmorland County.

STATION 10BR01BT0009

LAT. = 46D 13M 10S LONG. = 64D 33M 6S

Description: Municipal water supply, well no. 1, Westmorland County.

STATION 10BR01BT0010

LAT. = 46D 12M 21S LONG. = 64D 33M 57S

Description: Town of Shediak, well, Shediak, Westmorland County.

STATION 10BR01BY0012

LAT. = 45D 18M 50S LONG. = 64D 15M 10S

Description: Cape Pele School, Dept. of Education well, Cape Pele, Westmorland County.

STATION 10BR01BT0014

LAT. = 46D 10M 17S LONG. = 64D 33M 26S

Description: Penn Drill PGM, well 190, Dorchester Crossing, Westmorland County.

STATION 10BR01BT0015

LAT. = 46D 5M 23S LONG. = 64D 25M 1S

Description: Penn Drill PGM, well 214, Drisdelle, Westmorland County.

STATION 10BR01BT0016

LAT. = 46D 10M 29S LONG. = 64D 24M 58S

Description: Penn Drill PGM, well 189, Bourgeois Mills, Westmorland County.

STATION 10BR01BT0017

LAT. = 46D 9M 43S LONG. = 65D 27M 13S

Description: Penn Drill PGM, well 187, Petit Cap, Westmorland County.

STATION 10BR01BT0018

LAT. = 46D 3M 26S LONG. = 65D 33M 54S

Description: Penn Drill PGM, well 213, Anderson Settlement, Westmorland County.

STATION 10BRO1BT0019

LAT. = 46D 6M 8S LONG. = 70D 7M 18S

Description: Penn Drill PGM, well 212, Woodside, Westmorland County.

STATION 10BRO1BT0020

LAT. = 46D 10M 30S LONG. = 64D 01M

Description: Penn Drill PGM, well 186, Cadman Corner, Westmorland County.

STATION 10BRO1BT0021

LAT. = 46D 10M 0S LONG. = 63D 53M

Description: Penn Drill PGM, well 185, Spence Settlement, Westmorland County.

STATION 10BRO1BT0022

LAT. = 46D 5M 30S LONG. = 63D 49M

Description: Penn Drill PGM, well 209, Cape Spear Settlement, Westmorland County.

STATION 10BRO1BT0023

LAT. = 46D 4M 30S LONG. = 63D 56M

Description: Penn Drill PGM, well 210, Upper Cape, Westmorland County.

STATION 10BRO1BT0024

LAT. = 46D 4M 5S LONG. = 64D 26M

Description: Penn Drill PGM, well, Westmorland County.

STATION 10BRO1BT0025

LAT. = 45D 59M LONG. = 64D 4M

Description: Penn Drill PGM, well 229, Tidnish Bridge, Westmorland County.

STATION 10BRO1BT0026

LAT. = 45D 59M 0S LONG. = 64D 9M 0S

Description: Penn Drill PGM, well 230, Halls Hill, Westmorland County.

STATION 10BRO1BT0027

LAT. = 45D 52M 45S LONG. = 64D 16M 12S

Description: Penn Drill PGM, well 251, Aulac, Westmorland County.

STATION 10BRO1BT0028

LAT. = 45D 43M 1S LONG. =

Description: Penn Drill PGM, well 271, Frosty Hollow, Westmorland County.

STATION 10BRO1BT0029

LAT. = 45D 47M 27S LONG. = 64D 26M 39S

Description: Penn Drill PGM, well 288, Blacks Point, Westmorland County.

STATION 10BRO1BT0030

LAT. = 45D 55M LONG. = 64D 26M

Description: Penn Drill PGM, well 252, Fairfield, Westmorland County.

STATION 10BRO1BT0031

LAT. = 45D 59M 36S LONG. = 64D 18M 3S

Description: Penn Drill PGM, well 231, Midgic Station, Westmorland County.

STATION 10BRO1BT0032

LAT. = 45D 52M 51S LONG. = 64D 15M 36S

Description: Mr. Marshall, well, Mount Whatley, Sackville, Westmorland County.

STATION 10BR01BT0033

LAT. = 45D 50M 18S LONG. = 64D 22M 40S

Description: Weed Point observation well, well, Wood Point, Westmorland County.

STATION 10BR01BT0034

LAT. = 45D 53M 36S LONG. = 64D 22M 13S

Description: Town of Sackville, well, Sackville, Westmorland County.

STATION 10BR01BT0035

LAT. = 46D 3M 2S LONG. = 64D 5M 15S

Description: Town of Port Elgin, well, Port Elgin, Westmorland County.

STATION 10BR01BT0036

LAT. = 45D 19M 43S LONG. = 64D 30M 37S

Description: Town of Shediac, well, Shediac, Westmorland County.

STATION 10BR01BT0045

LAT. = 45D 58M 10S LONG. = 64D 24M 30S

Description: Sackville OBS well #1, Mount View Road, Sackville, Westmorland County.

STATION 10BR01BT0046

LAT. = 45D 57M 50S LONG. = 64D 24M 45S

Description: Sackville OBS well #2, Mount View Road, Sackville, Westmorland County.

STATION 10BR01BT0047

LAT. = 45D 58M 5S LONG. = 64D 24M 50S

Description: Sackville OBS well #3, Mount View Road, Sackville, Westmorland County.

STATION 10BR01BT0048

LAT. = 45D 57M 45S LONG. = 64D 24M 30S

Description: Sackville OBS well #4, Mount View Road, Sackville, Westmorland County.

STATION 10BR01BU0001

LAT. = 45D 58M 2S LONG. = 64D 34M 52S

Description: Village of St. Joseph, Westmorland County.

STATION 10BR01BU0003

LAT. = 45D 56M 30S LONG. = 64D 36M 17S

Description: F. LeBlanc, kitchen tap, Belliveau Village, East Road to St. Joseph, Westmorland County.

STATION 10BR01BU0006

LAT. = 45D 54M 35S LONG. = 64D 30M 5S

Description: Dorchester Penitentiary, new well west of penitentiary taken between hwy paralleling Keillor Brook, Dorchester, Westmorland County.

STATION 10BR01BU0008

LAT. = 46D 0M 7S LONG. = 64D 33M 4S

Description: Well at post office, Memramcook, Westmorland County.

STATION 10BR01BU0011

LAT. = 45D 58M 30S LONG. = 64D 32M 30S

Description: Boss Point Formation, College Bridge, Westmorland County.

STATION 10BRO1BU0015
LAT. = 46D 3M 30S LONG. = 64D 49M 30S
Description: 58 Wilson Road, Riverview, Albert County.

STATION 10BRO1BU0020
LAT. = 46D 0M LONG. = 65D 0M
Description: 101 Muncy Drive, Riverview, Albert County.

STATION 10BRO1BU0040
LAT. = 46D 11M 59S LONG. = 65D 1M 14S
Description: Hole no. 194, observation well, Gallagher Ridge, Westmorland County.

STATION 10BRO1BU0042
LAT. = 46D 14M 41S LONG. = 65D 6M 52S
Description: Hole no. 171, observation well, Canaan, Westmorland County.

STATION 10BRO1BU0043
LAT. = 46D 10M 48S LONG. = 65D 9M 35S
Description: Hole no. 195, observation well, Canaan Game Refuge, Westmorland County.

STATION 10BRO1BU0046
LAT. = 46D 12M 11S LONG. = 65D 16M 34S
Description: Hole no. 172, observation well, Throne, Westmorland County.

STATION 10BRO1BU0051
LAT. = 45D 56M 35S LONG. = 64D 31M 55S
Description: W. Bowser, well, R.R. 1, Upper Dorchester, Westmorland County.

STATION 10BRO1BU0055
LAT. = 45D 54M 24S LONG. = 65D 5M 35S
Description: Penn Drill PGM, well 257, Pollett River, Westmorland County.

STATION 10BRO1BU0058
LAT. = 45D 51M 5S LONG. = 65D 3M 10S
Description: Penn Drill PGM, well 275, Mapleton, Westmorland County.

STATION 10BRO1BU0059
LAT. = 45D 55M 45S LONG. = 65D 10M 40S
Description: Penn Drill PGM, well 258, Petitcodiac, Westmorland County.

STATION 10BRO1BU0060
LAT. = 45D 59M 19S LONG. = 65D 7M 4S
Description: Penn Drill PGM, well 237, River Glade, Westmorland County.

STATION 10BRO1BU0062
LAT. = 46D 0M 27S LONG. = 65D 3M 35S
Description: Penn Drill PGM, well 236, Salisbury, Westmorland County.

STATION 10BRO1BU0063
LAT. = 45D 56M 56S LONG. = 64D 58M 57S
Description: Penn Drill PGM, well 256, Nixon, Albert County.

STATION 10BRO1BU0064
LAT. = 45D 59M 46S LONG. = 64D 56M 48S
Description: Penn Drill PGM, well 235, Colpitts Settlement, Albert County.

STATION 10BR01BU0065
LAT. = 46D 0M 17S LONG. = 64D 52M 52S
Description: Penn Drill PGM, well 234, Lower Turtle Creek, Albert County.

STATION 10BR01BU0067
LAT. = 45D 52M 54S LONG. = 64D 54M 9S
Description: Penn Drill PGM, well 274, Berryton, Albert County.

STATION 10BR01BU0068
LAT. = 45D 55M 44S LONG. = 64D 48M 13S
Description: Penn Drill PGM, well 255, Steeves Mills, Albert County.

STATION 10BR01BU0069
LAT. = 45D 52M 51S LONG. = 64D 36M 47S
Description: Penn Drill PGM, well 254, Edgett Landing, Albert County.

STATION 10BR01BU0070
LAT. = 45D 49M 22S LONG. = 64D 38M 57S
Description: Penn Drill PGM, well 273, Woodworth Settlement, Albert County.

STATION 10BR01BU0072
LAT. = 46D 08M LONG. = 64D 41M
Description: Penn Drill PGM, well 191, Lakeville, Westmorland County.

STATION 10BR01BU0073
LAT. = 45D 30M LONG. = 65D 30M
Description: Dept. Nat. Resources 78-1-A, well, Salina, Albert County.

STATION 10BR01BU0074
LAT. = 46D 0M LONG. = 65D 30M
Description: Dept. Nat. Resources 78-2-A, well, Plumweseep, Albert County.

STATION 10BR01BU0075
LAT. = 46D 0M LONG. = 65D 30M
Description: Dept. Nat. Resources 78-3-A, well, Cornhill, Albert County.

STATION 10BR01BU0076
LAT. = 46D 0M LONG. = 65D 30M
Description: Dept. Nat. Resources 78-4, spring, Manhurst, Albert County.

STATION 10BR01BU0082
LAT. = 45D 53M 58S LONG. = 64D 30M 50S
Description: Town of Dorchester, well, Dorchester, Westmorland County.

STATION 10BR01BV0004
LAT. = 45D 29M 40S LONG. = 65D 37M 2S
Description: Howard Drummond, Upperton, Kings County.

STATION 10NB01AH0001
LAT. = 46D 6M 30S LONG. = 66D 36M 50S
Description: Plaster Rock well water from Mrs. Wayne Estey, Plaster Rock, Victoria County.

STATION 10NB01AJ0006

LAT. = 46D 27M LONG. = 67D 38M

Description: Florenceville, well water from Don Trafford, Carleton County.

STATION 10NB01AK0002

LAT. = 45D 57M 51S LONG. = 66D 39M 33S

Description: Fredericton water supply from well 1, in Wilmot Park near intersection of Rookwood Avenue and Woodstock Road, York County.

STATION 10NB01AK0003

LAT. = 45D 57M 51S LONG. = 66D 39M 21S

Description: Fredericton water supply from well 3, in Wilmot Park 90 m SW of Odell Avenue and Woodstock Road intersection, York County.

STATION 10NB01AK0004

LAT. = 45D 57M 51S LONG. = 66D 39M 24S

Description: Fredericton water supply from well 4, in Wilmot Park near centre of park, 200 m SW of Odell Avenue and Woodstock Road intersection, Fredericton, York County.

STATION 10NB01AK0005

LAT. = 45D 57M 57S LONG. = 66D 37M 9S

Description: Fredericton water supply from Carleton Ward Fire Station, Fredericton, York County.

STATION 10NB01AK0006

LAT. = 45D 58M 21S LONG. = 66D 37M 57S

Description: Fredericton water supply from Bridge Street well on Cliffe Street at intersection of Dedham and Cliffe streets, Fredericton, York County.

STATION 10NB01AK0007

LAT. = 45D 57M 0S LONG. = 66D 38M 57S

Description: Fredericton water supply from 661 Chesnut Street, Fredericton, York County.

STATION 10NB01AK0008

LAT. = 45D 57M 54S LONG. = 66D 39M 6S

Description: Fredericton water supply from domestic tap, Fredericton, York County.

STATION 10NB01AK0009

LAT. = 45D 56M 51S LONG. = 66D 38M 33S

Description: Fredericton water supply from U.N.B., Chemistry Bldg., Fredericton, York County.

STATION 10NB01AK0010

LAT. = 45D 58M 45S LONG. = 66D 37M 30S

Description: Fredericton water supply from well, Fredericton, York County.

STATION 10NB01AK0011

LAT. = 45D 57M 57S LONG. = 66D 39M 33S

Description: Fredericton water supply from well 5, on south bank of Saint John River, 175 m NW of Rookwood Avenue and Woodstock Road intersection, Fredericton, York County.

STATION 10NB01AK0012

LAT. = 45D 58M 57S LONG. = 66D 38M 57S

Description: Nashwaaksis well 4, Teak Drive at intersection with Brid Avenue, Nashwaaksis, York County.

STATION 10NB01AK0015

LAT. = 45D 58M LONG. = 66D 39M

Description: Fredericton well water from Simon Curtis, Fredericton, York County.

STATION 10NB01AK0018

LAT. = 45D 58M 57S LONG. = 66D 38M 57S

Description: Fredericton well water from Mrs. Gordon Corey, Fredericton, York County.

STATION 10NB01AK0028

LAT. = 45D 58M 51S LONG. = 66D 39M 12S

Description: Fredericton water supply from Nashwaaksis no. 1 at intersection of Fulton Avenue and Maple Street, Fredericton, York County.

STATION 10NB01AK0029

LAT. = 45D 58M 48S LONG. = 66D 38M 57S

Description: Fredericton water supply from Nashwaaksis no. 2, on Maple Street near intersection of Maple Street and Oak Avenue, Fredericton, York County.

STATION 10NB01AK0030

LAT. = 45D 58M 39S LONG. = 66D 38M 27S

Description: Fredericton water supply from Nashwaaksis no. 3, on Maple Street near intersection of Maple Street and Douglas Avenue, Fredericton, York County.

STATION 10NB01AK0040

LAT. = 45D 57M 54S LONG. = 66D 46M 45S

Description: Fredericton water supply from Silverwood no. 4, 270 m SE of intersection at TCH and MacIntosh Brook, Fredericton, York County.

STATION 10NB01AK0041

LAT. = 45D 58M 05 LONG. = 66D 43M 35

Description: Rosewood Estates Subdivision, private well near TCH 200 m west of intersection with Woodstock Road, Fredericton, York County.

STATION 10NB01AM0001

LAT. = 45D 51M 05 LONG. = 66D 29M 05

Description: Oromocto well water from Robert Costigan, drilled well, 30 m, Oromocto, Sunbury County.

STATION 10NB01AM0002

LAT. = LONG. =

Description: Lower Wassis well water from tap at home on Camp Road, Lower Wassis, Sunbury County.

STATION 10NB01BL0001

LAT. = 47D 44M 24S LONG. = 64D 43M 21S

Description: Shippegan well 3, Shippegan, Gloucester County.

STATION 10NB01BL0003

LAT. = 47D 43M 30S LONG. = 64D 44M 05

Description: Shippegan well water from Ernest Dorion, Shippegan, Gloucester County.

STATION 10NBO1BL0022
LAT. = 47D 47M 0S LONG. = 64D 38M 0S
Description: Lameque Fish Meal pump house water 12 m below surface, Lameque, Gloucester County.

STATION 10NBO1BL0023
LAT. = 47D 47M 0S LONG. = 64D 38M 0S
Description: Lameque Fire Station well, Lameque, Gloucester County.

STATION 10NBO1BL0024
LAT. = 47D 47M 0S LONG. = 64D 38M 0S
Description: Lameque Fire Station well, Lameque, Gloucester County.

STATION 10NBO1BL0025
LAT. = 47D 47M 0S LONG. = 64D 38M 0S
Description: Lameque well water, Lameque, Gloucester County.

STATION 10NBO1BL0026
LAT. = 47D 47M 0S LONG. = 64D 38M 0S
Description: Lameque hospital well water, Lameque, Gloucester County.

STATION 10NBO1BL0027
LAT. = 47D 47M 0S LONG. = 64D 38M 0S
Description: Lameque well water from Co-op Arena, Lameque, Gloucester County.

STATION 10NBO1BL0028
LAT. = 47D 47M 0S LONG. = 64D 38M 0S
Description: Lameque well water from Co-op Arena, Lameque, Gloucester County.

STATION 10NBO1BL0029
LAT. = 47D 47M 0S LONG. = 64D 38M 0S
Description: Lameque School (old) well water, Lameque, Gloucester County.

STATION 10NBO1B00001
LAT. = 46D 44M 0S LONG. = 65D 26M 0S
Description: Rogersville post office well, Rogersville, Northumberland County.

STATION 10NBO1B00002
LAT. = 47D 2M 0S LONG. = 65D 28M 0S
Description: Chatham municipal water supply, raw from Cassidy Well, Chatham, Northumberland County.

STATION 10NBO1B00003
LAT. = 47D 2M 0S LONG. = 65D 28M 0S
Description: Chatham municipal water supply, raw from Howard Well, Chatham, Northumberland County.

STATION 10NBO1B00004
LAT. = 47D 2M 0S LONG. = 65D 28M 0S
Description: Chatham municipal water supply, raw from Richard Well, Chatham, Northumberland County.

STATION 10NB01BQ0001

LAT. = 47D 0M 0S LONG. = 65D 32M 51S

Description: Newcastle municipal water supply, raw from Town Hall, comp. of 6 wells, Newcastle, Northumberland County.

STATION 10NB01BT0002

LAT. = 46D 13M 0S LONG. = 64D 32M 0S

Description: Shediac municipal water supply, raw from 2 deep wells, Shediac, Westmorland County.

STATION 10NB01BU0002

LAT. = 45D 55M 0S LONG. = 64D 37M 0S

Description: Dorchester post office, Dorchester, Westmorland County.

STATION 10NB01AJ0001

LAT. = 46D 18M 0S LONG. = 67D 31M 48S

Description: Hartland Spring at Hartland, Carleton County.

STATION 11BR01AK0013

LAT. = 45D 55M 1S LONG. = 66D 36M 50S

Description: Landfill site, stream discharge, Fredericton, York County.

STATION 11BR01AP0013

LAT. = 45D 32M 20S LONG. = 65D 50M 10S

Description: Carol Maltby, spring, 308 Main Street, Hampton, Kings County.

STATION 11BR01AP0040

LAT. = 45D 32M 25S LONG. = 65D 50M 0S

Description: L. Mills, spring, 28 Dutch Point Road, Hampton, Kings County.

STATION 11BR01B00001

LAT. = 47D 1M 30S LONG. = 65D 28M 10S

Description: Spring at Richard Street well, corner of Church and Johnson avenues, Chatham, Northumberland County.

STATION 11BR01B00003

LAT. = 47D 0M 25S LONG. = 65D 29M 55S

Description: Chatham Reservoir Dam, Chatham, Northumberland County.

STATION 11BR01BU0001

LAT. = 45D 58M 9S LONG. = 64D 34M 6S

Description: Bourgeois Spring, Village of St. Joseph, Westmorland County.